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A STUDY OF THE PARASITES OF THE FLORIDA MOUSE, *PEROMYSCUS FLORIDANUS*, IN RELATION TO HOST AND ENVIRONMENTAL FACTORS

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A STUDY OF THE PARASITES OF THE FLORIDA MOUSE, *PEROMYSCUS FLORIDANUS*, IN RELATION TO HOST AND ENVIRONMENTAL FACTORS[1]

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I. Introduction

The kinds and abundance of parasites associated with a particular mammalian host depend upon a complex interaction of many factors. Knowledge of these factors and their relative importance is essential to a full understanding of the significance of parasitism in terms of the biology of the host. In the present study an attempt has been made to obtain as complete a representation as possible of the parasitic fauna of the Florida mouse, *Peromyscus floridanus* (Chapman), and to examine the relationships between the occurrence and prevalence of particular parasite species or larger groups and such factors as age, sex, and density of host, habitat, and season.

Peromyscus floridanus occurs only in Florida, where it is further restricted in its distribution to a narrow range of habitats in certain parts of the state. It is taxonomically distinct from other species of the abundant and widespread genus *Peromyscus* and is referred to the monotypic subgenus *Podomys*. The Florida mouse apparently has affinities with western species. Its presently restricted range probably represents the survival in a Floridian refuge of a formerly more widespread population eliminated in other parts of its range by environmental changes during the Pleistocene. Information on the parasites of this rodent is therefore of interest both from the standpoint of its contribution to a knowledge of the population dynamics and environmental relationships of the species in its present range and habitats as well as perhaps providing some indication of the ecological factors that might have played a role in its evolutionary and distributional history.

II. Materials and Methods

The data on parasites included in this paper were obtained from over 800 mice collected between February, 1957, and October, 1960. Collections were made at 35 localities. Thirty-three of these were in six counties (Alachua, Clay, Gilchrist, Levy, Putnam, and St. Johns) in the northern half of peninsular Florida and two were in Highlands County in the southern part of the State (Fig. 1). All of the known habitats of *P. floridanus* were sampled, in approximate proportion to their importance, and an attempt was made to procure adequate seasonal representation from each habitat type. However, low population levels in some habitats prevented obtaining sufficient numbers of mice in all seasons.

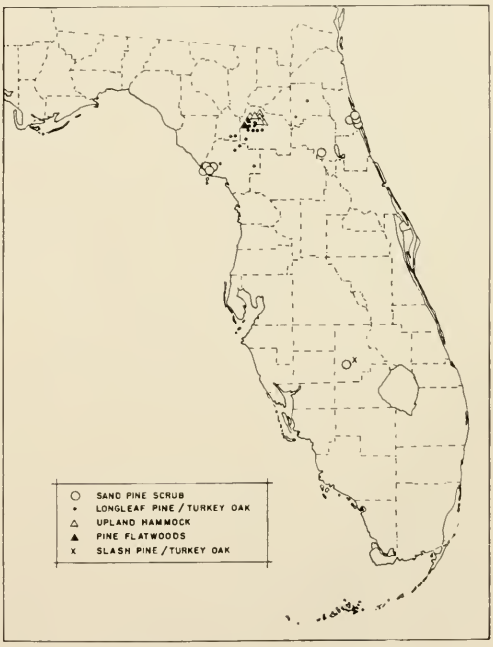

Figure 1. Map of peninsular Florida showing location of habitat types sampled.

Mice were collected with small (2 x 2½ x 6½ in.) Sherman live traps baited with rolled oats. The majority of specimens examined for parasites were trapped specifically for laboratory data. A smaller number of animals from which parasite data were

[1] This study was supported by Grants No. G-3215 and No. G-13240 from the National Science Foundation.

obtained consisted of specimens that had died in traps during mark-and-release studies.

Traplines of varying numbers of stations spaced at approximately 50-ft. intervals were used in general collecting. Two traps were set at each station. Traplines ordinarily were run for periods of one to three days, and the number of mice taken per 100 trapnights was used as a general index of population density. Traps on mark-and-release study plots were set in a grid pattern of 50- or 100-ft. intervals.

Samples of from 542 to 610 mice were examined for different types of ectoparasites. Most of the specimens were brought alive to the laboratory in traps. Each mouse was then transferred directly to a waxed sandwich bag containing a pledget of ether-soaked cotton. After the mouse had died, the bag was torn open along the sides and the specimen, cotton, and bag carefully searched for parasites. After the ectoparasites that had dropped off the specimen into the bag or become entangled in the cotton were collected, the mouse was carefully combed and examined, usually with the aid of a dissecting microscope, to recover those still attached or lodged in the pelage. In some cases, specimens were quick frozen in the waxed bags after death and examined at a later time. Mice found dead in traps on mark-and-release study areas usually were kept in plastic bags until examined.

The majority of the mice obtained in the course of general collecting or from live-trapping study plots were routinely surveyed for the more conspicuous types of endoparasites at the time of necropsy. The liver, stomach, and intestines of most of the mice were preserved in 10% formalin. The livers of 698 specimens were subjected to a formalin-ether concentration technic (Ritchie, 1948) for examination for certain helminth eggs, and the alimentary tracts of 186 specimens from different habitats were intensively searched for parasites. In addition, a detailed survey for endoparasites was made in a series of 38 freshly-killed mice. Urine and kidney tissue of four mice from a single locality were cultured and examined for leptospires, and blood samples from the same individuals were tested for leptospire antibodies. Blood smears from a number of specimens taken during the course of the study were checked for parasites after staining with Wright's.

Fleas, lice, ticks, and botfly larvae occurring on individual hosts were counted. The presence of mites was recorded. Although actual counts of individuals on infested hosts were not made, relative abundance was noted. Because of limitations of time, not every ectoparasite collected was identified. The percentages of infested hosts from which parasites in a particular group were identified are as follows: trombiculid mites, 5%; non-trombiculid mites, 85%; ticks, 70%; lice, 100% (only 1 collected); fleas, 88%; and cuterebrids, 100%. All endoparasites collected were identified to the lowest taxonomic level possible, and numbers and sites of occurrence in the host were recorded for helminths and pentastomids. The abundance of intestinal protozoans was estimated from microslide preparations of fecal smears stained with hematoxylin.

For the purposes of this study, two age classes of mice were recognized: young and adult. The former category included mice in juvenal pelage or undergoing the postjuvenal molt, and the latter, specimens in which the postjuvenal molt was complete. These age classes correspond to chronological ages of approximately 4 to 16 weeks and 17 weeks or older, respectively.

III. Description of Habitats

Mice were collected from several major habitat types that are essentially equivalent to ones recognized by Rogers (1933), Carr (1940), and Laessle (1942, 1958). These habitats, together with the number of stations of each type sampled, include: sand pine scrub—10, longleaf pine/turkey oak—16, slash pine/turkey oak—1, upland hammock—6, and pine flatwoods—2. The upland hammock category employed here corresponds to that termed "ecotonal" in an earlier paper (Layne and Griffo, 1961).

The Florida mouse typically is associated with sand pine scrub and longleaf pine/turkey oak habitats. Sand pine scrub is found on fine, white, and excessively well-drained sandy soils. Sand pine (*Pinus clausa*) and three species of oaks of shrubby habit (*Quercus myrtifolia, Q. virginiana,* and *Q. chapmanni*) are diagnostic woody plants of this association. In most of the scrubs sampled in this study, the sand pines were widely spaced, and the oaks formed dense, low clumps with extensive patches of bare sand between them. Forbs were sparse, and the

litter layer was largely restricted to the area beneath clumps of shrubs. Two of the stations included in the scrub category were somewhat atypical in that slash pine (*Pinus elliottii*) replaced sand pine. In all other respects, however, these areas were similar to true scrub.

The longleaf pine/turkey oak association also occurs on well-drained sandy soils, usually on low ridges or hills. Longleaf pine (*Pinus australis*) and turkey oak (*Q. laevis*) are ordinarily the only common tree species present. The pine is often sparse and in some instances may be absent. At some of the stations studied the oaks were so closely spaced as to produce nearly a closed canopy, but in most cases the stand was more open. The shrub and sapling understory varied from dense and brushy to nearly absent. Forbs were generally more abundant than in sand pine scrub habitats, and the ground cover was ordinarily better developed. Wire grass (*Aristida stricta*) is a characteristic component of the ground vegetation in longleaf pine/turkey oak habitats and may be present as scattered clumps or form a nearly continuous cover. The former condition, in which open patches of ground are frequent, is preferred by the Florida mouse. As the turkey oak is deciduous, the seasonal change in the aspect of the vegetation is more pronounced in the longleaf pine/turkey oak habitats than in the others studied.

The slash pine/turkey oak association has a limited distribution in the southern part of the state. It is intermediate between scrub and typical longleaf pine/turkey oak in species composition and general aspect.

Upland hammocks are open woodlands with sandy soils that contain more organic matter than those of the foregoing habitats and which, though still quite dry and well drained, tend toward a moister state than either scrub or pine/oak associations. Southern red oak (*Q. falcata*) is a characteristic tree in upland hammocks and a number of other species, including persimmon. (*Diospyros virginiana*), mockernut hickory (*Carya tomentosa*), loblolly pine (*Pinus taeda*), and laurel oak (*Q. laurifolia*) may also occur. The understory and ground cover ranged from heavy to sparse in the examples included in this study. Those stations that produced the best catches of mice usually had numerous stumps, logs, and bare patches of exposed soil. Also included in the upland hammock category are several stations representing ecotones between longleaf pine/turkey oak and mesic hammocks (broad-leaved woodlands containing such evergreen species as American holly and magnolia) and live oak hammocks. Both of these types environmentally were similar to typical upland hammocks. The ecotone sites had essentially the same species composition and aspect, differing chiefly in being more limited in extent and thus possibly more influenced by contiguous habitats. Live oak hammocks differed from typical upland hammocks in having the live oak as the dominant tree and a lesser variety of other woody plants. The understory was usually more open than in most of the upland hammocks with red oak as the principal tree as the result of closer spacing of the live oaks.

Pine flatwoods occupy level, poorly drained soils that are relatively rich in organic matter. Pines are the dominant trees, with the particular species present depending largely upon the edaphic conditions of the site. The understory may be variously developed and may include young pines and a variety of hardwood species. The lower strata are typically dense and may range from mostly shrubs or palmetto, or an intermixture of both, to principally grasses and forbs. As is also true of the other habitats mentioned, fire is an important factor in determining the particular vegetative characteristics of flatwoods stands. *Peromyscus floridanus* apparently only rarely inhabits pine flatwoods, and then only the better drained types during dry seasons or years. In the present study, mice were collected in only two flatwoods sites, both with longleaf pine and grassy ground cover.

Sand pine scrub and longleaf pine/turkey oak are relatively xeric environments. Studies by Rogers (1933) of evaporation rates in six woodland habitats in northern Florida showed scrub and turkey oak to have the highest overall evaporation rates, with the former having the greatest increment due to insolation (Fig. 2). Cooper *et al.* (1959) recorded temperatures in the litter layer of a scrub stand in central Florida. Monthly maximum temperatures were over 100° F every month of the year and above 125° in 8 months. The highest values occurred from

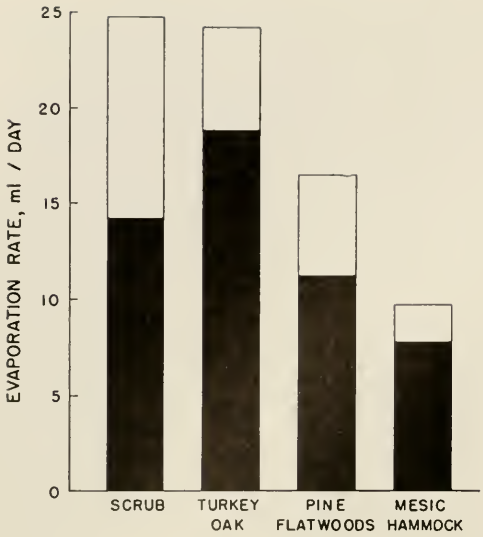

Figure 2. Average evaporation rates in four habitats in northern Florida. Based on weekly measurements given by Rogers (1933) for the period from 26 February through 23 July. White and black bulb atmometer readings are shown by solid and open portions of bars, respectively. The latter represent the increment due to insolation.

May through August, exceeding 160° in June.

Slash pine/turkey oak habitats on the basis of general observations appear to agree closely with scrub and typical turkey oak in their environmental conditions.

Upland hammocks, though still comparatively dry, are less so than the preceding habitats. They occupy an intermediate position on the moisture scale between sand pine scrub and mesophytic hammocks, which are considered to represent the climax community in northern Florida (Laessle, 1942).

The environment of pine flatwoods is subject to rather drastic fluctuations; therefore this habitat type does not fit as neatly into a sequence based on a moisture gradient as do the preceding. During droughty periods, flatwoods may be exceedingly dry, only to become quickly flooded after a brief period of rain. Under normal weather conditions, however, flatwoods are probably appreciably more mesic than either scrub or turkey oak, and possibly upland hammocks as well.

IV. Results

A. *Mites*

1. *Species records and relationships to host.*—Seven species of mites in four families were recorded. These include *Euschongastia peromysci* (Ewing), *Gahrlepia* (*Walchia*) *americana* Ewing, and *Trombicula crossleyi* Loomis of the family Trombiculidae; *Eulaelaps stabularis* (C. L. Koch) and *Haemogamasus liponyssoides* Ewing of the family Haemogamasidae; *Ornithonyssus bacoti* (Hirst) of the family Dermanyssidae; and *Haemolaelaps glasgowi* (Ewing) of the family Laelaptidae.

Trombiculid mites were collected from within the external auditory meatus, on the margin of the pinnae, and from the underside of the tail base, edge of the anus, and external genitalia. The ear canal was the most frequent site of attachment of chiggers, and ear-infesting chiggers were the most frequent ectoparasites recorded. The prevalence of chiggers in the ears of 610 specimens examined was 69.3%, as compared to 4.3% for infestations on other parts of the body. Trombiculids occurred in the ears of 70.5% of 519 adults and in 62.6% of 91 young, whereas infestations on other parts of the body were observed in 3.8% of the adults and 6.6% of the young. In neither case were the age differences significant when tested by chi-square ($P > .05$).

Samples of trombiculids for identification were collected from 22 mice selected at random from different habitats. In this series, *T. crossleyi* occurred on 10 hosts, *E. peromysci* on 7, *Trombicula* sp. on 6, and *G. americana* on 4. *T. crossleyi* was found in the ear canal of all specimens except 1, which had a single mite of this species beneath the base of the tail. Clusters of numerous individuals ordinarily occurred in the ear canal. *Trombicula* sp. was taken once on the margin of the pinna and 5 times on the underside of the tail base or on the perineal areas. *E. peromysci* was recorded only from the ear canal, and *G. americana* only from the ventral tail base and perineum. These limited data suggest species differences in the selection of attachment sites.

Trombicula sp. and *G. americana* occurred together on 2 of the 22 hosts from which chiggers were identified, *Trombicula* sp. and *T. crossleyi* on 1, and *T. crossleyi* and *E. peromysci* on 2. In view of the similarity

of attachment site and the high frequency of single infestations of the last two species, the seemingly low number of joint occurrences may indicate competition as the result of similar niche requirements, as was suggested for other trombiculid species by Jameson and Brennan (1957).

Five-hundred and ninety mice were surveyed for mites other than trombiculids, and 25.9% of this sample was infested. The incidence of non-trombiculid mites on 497 adults was 28.0%, as compared to 15.0% on 93 young. The difference is highly significant on the basis of the chi-square test ($P<.01$).

Samples of body mites from 130 mice were identified. *H. glasgowi* was the commonest species, occurring on 118 (90.8%) of the specimens. *E. stabularis* was recorded from 10 (7.7%) of the mice, *H. liponyssoides* from 6 (4.6%), and *O. bacoti* from 2 (1.5%). The number of individuals of each species in the total sample indicates the same order of abundance as does prevalence. Of the total of 389 randomly collected mites identified, 89.2% (299 adults, 148 nymphs) were *H. glasgowi;* 6.2% (24 adults), *E. stabularis;* 3.9% (3 adults, 12 nymphs), *H. liponyssoides;* and 1.0% (4 nymphs), *O. bacoti.* Mixed species infestations occurred in only 8 of the 130 samples. *E. stabularis, H. glasgowi,* and *H. liponyssoides* occurred together in 1 sample; *E. stabularis* and *H. glasgowi* in 3; and *H. glasgowi* and *H. liponyssoides* in 4.

The adult sex ratio in *H. glasgowi,* the only species represented by a sufficient number of specimens to warrant this calculation, was markedly unequal. Only 15 (5.2%) of 286 sexed specimens were males, as compared to 271 (94.8%) females.

2. *Effect of host density on prevalence.*— To analyze the effect of host density on the incidence of various groups of ectoparasites, three population levels were recognized. Catches of less than 5, 6-10, and 11 or more mice per 100 trapnights were designated as "low," "moderate," and "high" populations, respectively. The prevalence of parasitism at each density level was calculated by habitat and season, then comparisons of levels of prevalence in pairs of populations representing different density levels, *e.g.,* low-moderate, moderate-high, and low-high, were made. In those instances where a change of prevalence occurred with increase in population density, the average change in prevalence as well as the direction was determined. Because of seasonal effects on prevalence in a number of ectoparasites, actual comparisons of pairs of values were made within the same season. With the sizes of the samples involved, no difference could be seen in the direction or magnitudes of change associated with low-moderate, moderate-high, and low-high pairs, thus the data for these separate comparisons were combined into two density categories, "lower" and "higher."

The relationships between host density and prevalence of mites are shown in Tables 1 and 2. In the case of trombiculids, the differences in frequencies of the three possible categories of response of prevalence to higher host density fall far short of statistical significance when tested by chi-square ($.80>P>.70$). The differences between observed and expected frequencies in the three categories approach more closely to significance ($.10>P>.05$) in the case of non-trombiculid mites. Considering only the cases of increase or decrease of prevalence corresponding to higher population density, ear-infesting trombiculids exhibit nearly twice as many increases than decreases, with a correspondingly greater change in preva-

TABLE 1.
Influence of increased host density on the prevalence of trombiculid mites attached within the ear canal

Habitat	Number of Comparisons	No Change	Decrease		Increase	
		N	N	$\bar{x}$ change in prevalence	N	$\bar{x}$ change in prevalence
Sand pine scrub	4	1	1	64.1	2	62.5
Longleaf pine/turkey oak	5	0	4	14.4	1	6.1
Upland hammock	7	4	0	–	3	46.4
Pine flatwoods	1	–	–	–	1	52.6
Combined Habitats	17	5	5	24.3	7	46.1

TABLE 2.
Influence of increased host density on the prevalence of non-trombiculid mites

Habitat	Number of Comparisons	No Change	Decrease		Increase	
		N	N	$\bar{x}$ change in prevalence	N	$\bar{x}$ change in prevalence
Sand pine scrub	4	1	0	–	3	16.0
Longleaf pine/turkey oak	5	0	2	20.1	3	23.7
Upland hammock	5	0	3	29.4	2	37.6
Pine flatwoods	1	0	1	25.8	0	–
Combined Habitats	15	1	6	25.7	8	24.3

lence in the increase than in the decrease category. A similar but less pronounced trend is suggested by the data for non-trombiculid mites. In neither group of parasites, however, is the evidence for a correlation between host and parasite abundance particularly convincing.

3. *Effect of habitat on prevalence.*—None of the trombiculid mite species was recorded from all of the habitats studied. *T. crossleyi* occurred in sand pine scrub, longleaf pine/turkey oak, and upland hammock; *Trombicula* sp. in longleaf pine/turkey oak and upland hammock; *G. americana* in scrub and longleaf pine/turkey oak; and *E. peromysci* in scrub, upland hammock, and flatwoods. Since the sample of identified trombiculids was small, there is some question as to how accurately the above data reflect the actual habitat tolerances of the several species represented. Most likely further sampling would have increased the known habitat distribution of at least some of the forms.

Table 3 gives the seasonal and overall prevalence of trombiculid mites in the four major habitat types studied. The incidence of trombiculids in the ear canal, presumably mostly or entirely *T. crossleyi* and *E. peromysci*, varies markedly with habitat. The prevalence ranges from a low of 41.4% in scrub to a high of 83.0% in upland hammock, with intermediate values for turkey oak (70.6%) and flatwoods (65.5%). When an R x C test for independence (Snedecor, 1946) is applied to these data, with the calculation of expected values for individual habitats being based on the incidence in all habitats combined, the observed differences are highly significant ($P<.01$). The incidence of trombiculids occurring on other parts of the body is low in all habitats, and the differences between habitats are not significant ($.20>P>.10$).

The trend in prevalence of ear-infesting trombiculids in relation to habitat probably is primarily a reflection of the environmental requirements of the free-living nymphal and adult stages. An influence of habitat on the prevalence of chiggers has been noted by a number of workers (*e.g.* Ewing, 1944; Jameson and Brennan, 1957; Michener, 1946; Mohr, 1947; Pearse, 1929; Worth, 1950), and in many instances abundance of chiggers has been correlated with habitats having a well-developed litter layer or heavy ground vegetation and relatively moist conditions. Jenkins (1947) found that *Eutrombicula batatas* laboratory colonies were most successful when maintained on a nearly saturated medium at temperatures ranging from 25 to 35° C. At relative humidities above 85%, optimum egg-laying took place between 27 and 34°, a decline occurring when temperature exceeded 35°. Apparently, therefore, temperature, humidity, and the development of litter or ground cover are among the critical factors determining the suitability of a given habitat for chiggers, a combination of relatively moist conditions, limited temperature fluctuation, and abundance of litter or ground cover tending to favor high populations.

Upland hammocks and pine flatwoods approach these conditions more closely than the other habitats represented in this study. Sand pine scrub apparently provides the poorest habitat for trombiculids, while typical longleaf pine turkey oak woodlands rank only slightly better. The lower prevalence of ear trombiculids in these habitats as compared to upland hammock bears out these assumptions. On the basis of general environmental conditions, flatwoods would

TABLE 3.
Habitat and seasonal prevalence of trombiculid mites within the ear canal and on other parts of the body

Period	Sand pine scrub			Longleaf pine/turkey oak			Upland hammock			Pine flatwoods		
	No. exam.	Percent infested		No. exam.	Percent infested		No. exam.	Percent infested		No. exam.	Percent infested	
		Ear canal	Other		Ear canal	Other		Ear canal	Other		Ear canal	Other
Jan.-Mar.	–	–	–	52	25.0	0.0	40	72.5	2.5	27	37.0	0.0
Apr.-June	82	20.7	4.9	12	41.7	0.0	54	46.3	1.8	31	90.3	9.7
July-Sept.	33	90.9	6.1	77	97.4	14.3	76	100.0	3.9	–	–	–
Oct.-Dec.	1	100.0	0.0	60	81.4	0.0	65	100.0	1.5	–	–	–
Total	116	41.4	5.2	201	70.6	5.5	235	83.0	2.6	58	65.5	5.2

TABLE 4.
Habitat and seasonal prevalence of non-trombiculid mites

Period	Sand pine scrub		Longleaf pine/ turkey oak		Upland hammock		Pine flatwoods	
	No. exam.	Percent infested	No. exam.	Percent infested	No. exam.	Percent infested	No. exam.	Percent infested
Jan.-Mar.	–	–	61	26.2	40	57.5	28	32.1
Apr.-June	81	19.8	20	40.0	54	44.4	31	25.8
July-Sept.	29	13.8	61	14.8	72	16.7	–	–
Oct.-Dec.	1	0.0	50	24.0	62	19.4	–	–
Total	111	18.0	192	23.4	228	31.1	59	28.8

be expected to have a relatively higher prevalence than that observed. The apparently low value for this habitat may be explainable, at least in part, on the basis of a sample bias. Data for other habitats indicate a strong interaction between habitat and season, with a marked increase in the abundance of chiggers in the period from July through December. This interval is not represented in the sample from flatwoods. Thus, if the same seasonal trend in chigger prevalence occurs in this habitat as in others, the overall prevalence should equal or even exceed that for upland hammock. The alternation between wet and dry conditions may also influence trombiculid populations in flatwoods.

Infestation rates of non-trombiculid mites are slightly higher in the moister habitats (Table 4). However, the observed frequencies in different habitats do not differ significantly from expected values based on the overall prevalence ($.02 > P > .05$). The occurrence and relative abundance of the individual non-trombiculid species identified from 130 mice taken in different habitats (Table 5) indicate that *H. glasgowi* is the most common species on *P. floridanus* in every habitat. It does not exhibit any pronounced habitat specificity, although Worth (1950) reported this species to be more prevalent in moist habitats in south Florida. *H. liponyssoides* is the only other species occurring in all habitat types, appearing to be most abundant in flatwoods. *E. stabularis* seems to be more abundant in the moister of the two environments, longleaf pine/ turkey oak and upland hammock, from which it was recorded.

The apparent low degree of correlation between habitat type and prevalence of non-trombiculid mites as compared to chiggers may be a reflection of the greater influence of physical environmental factors on the latter as a result of their free-living nymphal and adult stages. Since non-trombiculid species are parasitic in both nymphal and adult stages and require the host's nest for their life cycle, they may be more independent of the direct effects of environment than chiggers. Thus, over the environmental range encountered in this study, their populations may depend to a greater extent on the kinds and abundance of mammalian hosts in a given habitat.

4. *Effect of season on prevalence.*—When the data on prevalence of trombiculid mites in all habitats are combined into 3-month periods (January-March, April-June, July-September, October-December), pronounced seasonal trends in abundance are indicated. The prevalence of trombiculids in ears is low during the first six months of the year (43.7% for the January-March period and 41.9% for the April-June interval) and high in the last half of the year (97.3% in the July-September period and 90.4% in the October-December quarter). The differences

TABLE 5.
Percentages of mice carrying different non-trombiculid mites in four habitats

Species of Mite	Sand pine scrub	Longleaf pine/ turkey oak	Upland hammock	Pine flatwoods
Eulaelaps stabularis	–	5.6	11.3	–
Haemogamasus liponyssoides	5.6	2.8	3.2	21.4
Ornithonyssus bacoti	–	5.6	–	–
Haemolaelaps glasgowi	94.6	86.1	90.3	100.0

in prevalence in the quarterly periods are highly significant ($P<.01$) when tested for independence against expected values based on the overall incidence. Monthly infestation rates for all habitats give a more precise indication of seasonal trends in abundance of ear chiggers. The prevalence exceeded 90% from June through November, declined in December (79.6%) and January (82.1%), reached its lowest levels in February (4.5%), March (18.2%) and April (4.6%), then increased again in May (37.5%). These data indicate a yearly cycle in prevalence, with peak abundance occurring during the summer and fall months.

In the case of individual habitats, complete seasonal data on prevalence is available for longleaf pine/turkey oak and upland hammock, and in both habitats the seasonal trends are similar to those of the combined data. Although certain periods are not represented in the data for sand pine scrub and flatwoods, the trends suggested by the partial information also indicate agreement with the overall pattern. However, while the four habitats appear to exhibit the same seasonal patterns in prevalence, infestation rates in individual habitats during comparable seasons show considerable variation. Thus, upland hammock exhibits a higher incidence in the January-March period than either turkey oak or flatwoods (data not available from scrub for this interval), while flatwoods has a much higher prevalence in the April-June period than any of the other habitats. These differences probably represent the interaction between habitat and seasonal factors. For example, the generally higher prevalence in upland hammock and flatwoods during the early part of the year as compared to scrub and turkey oak may indicate a higher survival of trombiculids in these habitats during the winter as a result of more favorable cover, moisture, and temperature conditions.

Although the differences are less pronounced than those of ear-infesting trombiculids, the prevalence of chiggers on other parts of the body exhibits seasonal variation. The differences are highly significant ($P<.01$). The prevalence in the January-March and October-December periods was 0.8%, as compared to 4.5% in the April-June interval and 8.6% in the July-September quarter. The general trend is similar to that of ear trombiculids except that the peak in abundance may occur somewhat earlier.

The seasonal changes in abundance of chiggers probably reflect a response to climatic conditions, particularly temperature and humidity. The period of greatest abundance occurs when temperatures are high and rainfall is abundant. Strong seasonal trends in abundance of various species of trombiculids on mammalian hosts have been reported by other workers (e.g., Elton *et al.,* 1931; Jameson and Brennan, 1957; Michener, 1946; Worth, 1950), with peak abundance often coinciding with increased moistness of the habitat.

Seasonal differences in the prevalence of non-trombiculid mites are also pronounced. The departure of the observed frequencies for quarterly periods from expected values calculated from overall incidence is highly significant ($P<.01$). In contrast to chiggers, however, the increased prevalence of other mites occurred during the January-June period. The months of greatest abundance, 53.3% and 58.9%, respectively, were March and April. Insofar as data are available, these trends for individual habitats agree generally with that for all habitats combined. As in the case of trombiculids, differences in prevalence between habitats in comparable seasons probably reflect the interaction between habitat and season.

The observed trends in seasonal abundance of non-trombiculid mites are chiefly due to *Haemolaelaps glasgowi,* which is the most abundant species in the sample. The increased prevalence of this species during late winter and early spring agrees generally with the findings of Morlan (1952) and Smith and Love (1958). The latter also found *H. glasgowi* to be more abundant in wet years.

The increased occurrence of non-trombiculid mites on hosts in the cooler months may reflect a peak in an annual population cycle. This trend may also be the result, at least in part, of a greater tendency of mites to remain on the host rather than in the nest in cool weather. Paralleling the situation in the case of habitat, the seasonal changes in apparent abundance of non-trombiculids are of lesser magnitude than those of chigger mites. Again, this may indicate that the former, being more closely associated with the nest, are less subject to outside environmental conditions. A similar relationship

TABLE 6.
Influence of increased host density on tick prevalence

Habitat	Number of Comparisons	No Change	Decrease		Increase	
		N	N	$\bar{x}$ change in prevalence	N	$\bar{x}$ change in prevalence
Sand pine scrub	4	0	3	10.6	1	5.3
Longleaf pine/turkey oak	5	2	0	–	3	8.1
Upland hammock	9	1	5	10.9	3	10.8
Pine flatwoods	1	0	1	11.1	0	–
Combined Habitats	19	3	9	10.8	7	8.9

in the seasonal prevalence of trombiculids and other mites on small mammals in California was observed by Jameson and Brennan (1957).

B. *Ticks*

1. *Species records and relationships to host.*—Four species of ticks collected on *P. floridanus* included *Dermacentor variabilis* (Say), *Amblyomma maculatum* Koch; *Amblyomma americanum* (Linn.), and *Ixodes minor* Neumann (=*I. bishoppi* Smith and Gouck).* The prevalence of ticks on a total of 600 mice examined for these parasites was 7.8%. The prevalence on adults (7.2%) was not significantly different ($.50>P>.30$) from that on young (11.2%). *D. variabilis*, the only tick commonly represented, occurred on 29 of 33 hosts from which ticks were identified. All were nymphs or larvae. *A. americanum* (2 larvae) was collected on only two mice, and *A. maculatum* (1 nymph) and *I. minor* (1 adult), were each taken on a single host. The average number of ticks on infested hosts was 1.3. The number of *D. variabilis* larvae or nymphs on mice ranged from 1 to 8, with a mean of 1.6.

In a series of 39 infested mice, ticks were attached to the pinna of 31 (79.5%), to the shoulder of 6 (15.4%), and within the ear canal of 3 (7.7%). The one specimen of *I. minor* was attached to the shoulder.

2. *Effect of host density on prevalence.*—The frequencies of no change, decrease in prevalence, or increase in prevalence of ticks in comparisons between lower and higher host population levels (Table 6) do not differ significantly from those expected on a random basis ($.20>P>.10$). In contrast to mites there is slight indication of a negative correlation between tick prevalence and host density.

3. *Effect of habitat on prevalence.*—*D. variabilis* was recorded in each of the major habitats studied, whereas the other species were each taken in one habitat type: *I. minor* in scrub, *A. maculatum* in upland hammock; and *A. americanum* in longleaf pine/turkey oak. Because of the few records involved, the extent to which the data reflect actual habitat specificity of these ticks is questionable.

Table 7 presents the habitat and seasonal distribution of 47 tick infestations on 600 mice. The differences between observed and expected habitat-specific frequencies is highly significant ($P.<.01$), with the greatest number of infestations occurring in upland hammock. The increased prevalence of ticks in upland hammock habitats probably is due

*Smith and Gouck (1947) described *Ixodes bishoppi* from Georgia. However, according to G. M. Kohls (personal communication) *I. bishoppi* is probably a synonym of *I. minor* earlier described from Guatemala, and on this basis the latter name is employed in this paper.

TABLE 7.
Habitat and seasonal prevalence of ticks

Period	Sand pine scrub		Longleaf pine/ turkey oak		Upland hammock		Pine flatwoods	
	No. exam.	Percent infested	No. exam.	Percent infested	No. exam.	Percent infested	No. exam.	Percent infested
Jan.-Mar.	–	–	58	6.9	40	15.0	28	3.6
Apr.-June	81	2.5	16	0.0	54	16.7	31	0.0
July-Sept.	30	10.0	68	1.5	76	6.6	–	–
Oct.-Dec.	1	100.0	52	5.8	65	16.9	–	–
Total	112	5.4	194	4.1	235	13.6	59	1.7

mainly to the existence of favorable environmental conditions. The relatively high humidity of this habitat type, absence of extremely high temperatures, and abundance of brush, debris, and litter probably offer more suitable conditions for tick survival and reproduction than the other vegetative associations represented. Since the adult stages of the ticks recorded, except possibly *I. minor,* are found typically on larger mammals, the population levels of raccoons, opossums, bobcats, and foxes presumably would interact with habitat factors in influencing tick abundance. Evidence indicates that larger mammals were not abundant in the flatwoods habitats represented in the present study, and this might be at least partly responsible for the lower prevalence of ticks in this environment than would be predicted on the basis of vegetative characteristics alone.

4. *Effect of season on prevalence.*—The prevalence of ticks in 3-month intervals through the year was as follows: January-March, 8.7%; April-June, 6.4%; July-September, 5.2%; and October-December, 12.7%. Although the observed seasonal frequencies do not differ significantly ($.10 > P > .05$) from expected values, the limited data suggest, however, that tick abundance may be highest in the fall and early winter months.

C. *Lice*

One specimen of *Hoplopleura hirsuta* Ferris was collected in a sample of 574 mice examined, a prevalence of 0.2%. The louse was taken on a Florida mouse collected in pine flatwoods in March. The cotton rat, *Sigmodon hispidus,* was abundant at this locality, and in all probability the louse was a straggler from this host.

D. *Fleas*

1. *Species records and relationships to host.*—Four species of fleas recorded included *Polygenis floridanus* Johnson and Layne, *Polygenis gwyni* (Fox), *Ctenophthalmus pseudagyrtes* Baker, and *Hoplopsyllus affinis* (Baker).

One hundred and eighty (33.2%) of the 542 mice examined carried fleas. The prevalence of fleas on adults was 33.6% as compared to 30.8% on young, the difference not being statistically significant ($.90 > P > .80$). The numbers of adult males and females infested were practically equal (males, 33.3%; females, 34.0%), but a greater number of young males (36.8%) carried fleas than females (25.0%). The number of fleas on infested mice ranged from 1 to 16, averaging 2.3. The mean was somewhat lower in adults (2.2) than in young (3.0), but in neither age class did the flea index of the sexes differ appreciably (adult males, 2.3; adult females, 2.1; young males, 3.0; young females, 2.9).

Three hundred and sixty-five fleas were identified, this number representing all of the fleas carried by 158 of the 180 animals infested. *Polygenis floridanus* occurred on 94.9% (150) of the mice and comprised 92.3% (337) of the total identified sample. It was the only common flea on *Peromyscus floridanus,* being known thus far only from this host (Johnson and Layne, 1961). *Polygenis gwyni,* perhaps the most abundant flea on other small terrestrial rodents in Florida, occurred on only 10.1% (16) of the mice and constituted only 5.2% (19) of the sample. *C. pseudagyrtes* was taken on 5.1% (8) of the specimens and represented only 2.2% of the fleas determined. One *H. affinis* was collected. Since the typical hosts of this flea are hares and rabbits (Kohls, 1940), its presence on the Florida mouse is considered accidental.

The majority (89.8%) of infestations were of single species, and in no instance was more than two species of fleas found on the same host. *Polygenis floridanus* was the only flea recorded in 85.4% of the infestations, *P. gwyni* in 3.8%, and *C. pseudagyrtes* in 0.6%. *P. floridanus* and *gwyni* occurred together on 5.7% of the hosts, *P. floridanus* and *C. pseudagyrtes* on 3.8%, and *P. gwyni* and *C. pseudagyrtes* on 0.6%. The mean numbers of specimens per infested host of each species were: *P. floridanus,* 2.2; *P. gwyni,* 1.2; and *C. pseudagyrtes,* 1.0.

2. *Effect of host density on prevalence.*—The prevalence of fleas apparently is more closely related to host numbers than in the case of acarine parasites (Table 9); the effect of change in host density on the flea index is more pronounced than would be expected on the basis of chance ($P < .01$). In 22 pairs of values compared, an increase was recorded in 15 (68.2%) and a decrease in 6 (27.3%). The mean percentage change in prevalence in going from a lower to higher population was approximately equal

TABLE 8.
Influence of increased host density on flea prevalence

Habitat	Number of Comparisons	No Change	Decrease		Increase	
		N	N	$\bar{x}$ change in prevalence	N	$\bar{x}$ change in prevalence
Sand pine scrub	4	0	0	–	4	38.8
Longleaf pine/turkey oak	5	0	3	20.7	2	31.9
Upland hammock	12	1	2	51.5	9	26.1
Pine flatwoods	1	0	1	1.2	0	–
Combined Habitats	22	1	6	27.6	15	30.3

for both increases and decreases (Table 8) in infestation rates.

3. *Effect of habitat on prevalence.*—The differences in prevalence in different habitats are highly significant ($P<.01$). Infestations were more frequent than expected in sand pine scrub and longleaf pine/turkey oak and less so in upland hammock and pine flatwoods habitats (Table 9).

C. pseudagyrtes was collected in upland hammock and flatwoods only, its prevalence being 3.1 and 1.7%, respectively in the two habitats. *H. affinis* occurred in slash pine/turkey oak, from which numerous *Polygenis floridanus* were also obtained. *P. floridanus* and *gwyni* were each taken in the four major habitats studied, but the relative abundance of these species varied from one habitat to another. *P. gwyni* occurred most frequently in sand pine scrub (7.4%) and flatwoods (10.3%) and had a low prevalence in longleaf pine/turkey oak (1.3%) and upland hammock (0.9%). *P. floridanus,* on the other hand, was most abundant in sand pine scrub (34.6%) and longleaf pine-turkey oak (35.5%), and least so in upland hammock (23.8%) and flatwoods (27.6%).

A relationship between the host's environment and the occurrence and abundance of particular flea species has been shown by a number of workers, including Gabbutt (1961), Jameson (1947), Jameson and Brennan (1957), Pearse (1929), and Worth (1950). The habitat distribution of two of the flea species associated with the Florida mouse may be related mainly to the ecological distribution of their typical small mammal hosts, while that of the third may be due in greater measure to the direct effect of environmental factors. *C. pseudagyrtes* commonly occurs on moles and shrews, and the greater abundance of these mammals in upland hammocks and flatwoods than in either scrub or turkey oak probably accounts for the appearance of this flea on the Florida mouse only when it occurs in the first two habitats. *Polygenis gwyni* is a characteristic flea of the cotton rat. In this study cotton rats occurred commonly only in flatwoods and in certain scrub habitats, and it is in these vegetation types that *P. gwyni* is encountered most frequently on the Florida mouse. Within scrub habitats, the prevalence of *Polygenis gwyni* on the Florida mouse showed a close positive correlation with the size of the cotton rat population.

The greater abundance of *Polygenis floridanus* in scrub and turkey oak habitats than in upland hammock and flatwoods may be indicative of preference for more xeric conditions, since host predilection can be ruled out. The environmental distribution of flea and host show a close correspondence. Present data indicate that sand pine scrub and

TABLE 9.
Habitat and seasonal prevalence of fleas

Period	Sand pine scrub		Longleaf pine/ turkey oak		Upland hammock		Pine flatwoods	
	No. exam.	Percent infested	No. exam.	Percent infested	No. exam.	Percent infested	No. exam.	Percent infested
Jan.-Mar.	–	–	50	52.0	39	28.2	28	21.4
Apr.-June	50	40.0	14	92.8	68	30.9	31	41.9
July-Sept.	32	43.8	61	21.3	56	12.5	–	–
Oct.-Dec.	1	0.0	52	38.5	60	26.7	–	–
Total	83	41.0	177	40.7	223	24.7	59	32.2

longleaf pine/turkey oak are the primary habitat types of the Florida mouse. Upland hammock is less important, and the species occurs only sporadically in flatwoods, and then only under particular conditions. The low prevalence of *Polygenis floridanus* in flatwoods might be the result of general environmental conditions or specific microclimates of the nests of the host in this habitat. Also, possibly the initial flea population on mice dispersing from more favorable habitats may have been low.

4. *Effect of season on prevalence.*—Fleas were most abundant (41.0%) in the period from April to June, while the prevalence dropped to 22.8% in the July-September interval. In the following 3-month period infestations increased to 31.8% and rose still higher (36.8%) in the January-March interval. These values depart significantly ($P<.01$) from the assumption of equal prevalence in all seasons. Trends of seasonal abundance in upland hammock and longleaf pine/turkey oak agree with that of the combined data. Although data are available from only the January-June period in flatwoods, the trend in prevalence of fleas during this interval follows the general pattern also. In sand pine scrub, however, a higher prevalence is indicated for the July-September period relative to the April-June interval than in other habitats.

The one *H. affinis* was collected in April. *C. pseudagyrtes* was obtained in upland hammock habitats in March, April, and June; and in flatwoods in May. *P. gwyni* occurred on mice only during the first six months of the year. Its prevalence in the January-March interval was 3.1% and in the April-June period, 7.9%. The data for this species suggest, therefore, an increased abundance on hosts during the late winter and spring. Similar findings were reported for this species on cotton rats in Georgia by Morlan (1952) and Smith and Love (1958).

The overall seasonal trend in flea abundance can be attributed largely to *P. floridanus*. The prevalence of this species in the January-March period was 31.6%, in the April-June interval, 34.8%, in the July-September period, 22.0%, and in the October-December period, 28.4%. The mean number of fleas per infested host exhibited a similar trend, being 2.9, 2.5, 1.5, and 2.4 for the four periods. Copulating pairs of fleas were observed on hosts during live-trapping operations in March. Where comparable periods are represented, the data for individual habitats show about the same seasonal patterns. Sand pine scrub, however, appears to have peak flea abundance at a somewhat later time of the year than other habitats. The data indicate that the abundance of fleas on hosts is highest during the cooler months of the year, reaching a peak in the spring. The extent to which the trend involves actual changes in flea populations or seasonal differences in the activity or behavior of the fleas or hosts is unknown.

Total and seasonal sex ratios were calculated for *Polygenis floridanus*. In a sample of 378 specimens collected in all months of the year 48.9% were males, 51.1% females. The highest proportion of males (57.3%) occurred in the January-March sample, followed by the April-June period (48.6%). Males constituted 47.8% of the fleas collected in the July-September interval and only 42.1% of those from the October to December period. Although the sex ratios calculated for 3-month periods do not differ significantly ($.3>P>.2$) from equality, a trend toward a higher number of females in late fall and early winter is suggested. This may indicate a sex difference in temperature response similar to that shown for *Xenopsylla cheopis* by Cole (1945). The correlation of high flea prevalence and increased proportion of males in the spring with observed copulation suggests the possibility that changes in sex ratio or overall abundance of fleas on hosts also may be associated with reproductive activity.

E. *Botflies*

1. *Species record and relationships to host.*—The species of botfly, *Cuterebra,* infesting the Florida mouse is questionable. An unsuccessful attempt was made to rear specimens obtained from this host. However, adult flies were reared from larvae taken from cotton mice (*Peromyscus gossypinus*) trapped in the same habitats as *Peromyscus floridanus.* According to Dr. C. W. Sabrosky these forms, presumably the same parasitizing the Florida mouse, closely resemble *C. angustifrons* Dalmat, although differing slightly from the latter in some particulars.

The overall prevalence of *Cuterebra* larvae in 630 mice was 3.6% (23 specimens infected). The difference in infection be-

tween adults (3.5%) and young (4.4%) was not significant ($.98>P>.95$). The location of the bots was recorded for 20 mice. The larvae were located in the inguinal region of 18 specimens, in the lumbar region of 1, and in the sacral region of 1. Ten of 15 mice carrying living larvae had a single bot. Two larvae were present in each of 3 mice, and 2 animals each contained 3 larvae.

2. *Effect of host density on prevalence.*—Because of the low prevalence rate in other habitats, host abundance and prevalence of cuterebrids can be considered for upland hammock habitats only. In three pairs of values, the prevalence was decreased in two and increased in one case with higher population density. The small sample of course precludes drawing any definite conclusions about the relationship between prevalence of cuterebrids and host density, although, as suggested by the data for ticks, an increase of hosts might be associated under some circumstances with a reduction in the frequency of botfly infections. Wilson (1945) observed an increase in the occurrence of cuterebrids correlated with a low population of *Peromyscus leucopus,* and a similar trend is indicated by the data of Scott and Snead (1942) and Wecker (1962).

3. *Effect of habitat on prevalence.*—Habitat differences in the prevalence of botfly infections (Table 10) were highly significant in terms of expected values based on prevalence in all habitats combined ($P<.01$). Upland hammock was the only habitat type in which botfly infection reached significant proportions. The prevalence of infections in longleaf pine/turkey oak and pine flatwoods was low, and no mice with cuterebrid larvae were recorded from sand pine scrub. The apparently strong restriction of infections to upland hammock associations becomes even further pronounced when the data for longleaf pine/turkey oak areas are examined more closely. All of the records of botfly larvae in mice in this habitat type came from a single station in which a long term live trapping study is in progress. The study area consists of about 26 acres of longleaf pine/turkey oak habitat surrounded on two sides by mesophytic hammock, with a narrow ecotone between the two habitat types. The Florida mice in this area are confined largely to the turkey oak association, although some are trapped in the ecotone. None has ever been taken in the hammock. An examination of the trapping records of the infected individuals from this area showed that, although their home ranges lay largely in the turkey oak zone, occasionally they did range into the moister ecotone areas. No animals known to live entirely within the turkey oak were recorded with botfly infections.

The restricted ecological distribution of cuterebrid infections probably can be attributed to the effect of physical environmental factors on the adult or larval stages of the parasite. The adult flies may prefer moist, shady situations and may occur less frequently in more open, drier environments. Evidence on the life cycle of the forms infesting *Peromyscus* suggests that the flies lay their eggs around the homesites or in local areas frequented by the mice and that the eggs hatch into larval stages which are attracted by the proximity of the host (Dalmat, 1943; Penner and Pocius, 1956). A poorer survival of larval stages might also be a factor contributing to the low level of infections in the drier habitats.

4. *Effect of season on prevalence.*—Living bots or fresh exit sites were recorded

TABLE 10.
Habitat and seasonal prevalence of cuterebrid larvae

Period	Sand pine scrub		Longleaf pine/ turkey oak		Upland hammock		Pine flatwoods	
	No. exam.	Percent infected	No. exam.	Percent infected	No. exam.	Percent infected	No. exam.	Percent infected
Jan.-Mar.	–	–	58	0.0	40	4.5[a]	28	0.0
Apr.-June	72	0.0	23	0.0	56	5.4[b]	31	3.2
July-Sept.	46	0.0	70	0.0	77	2.6	–	–
Oct.-Dec.	1	0.0	63	6.3	65	16.9[c]	–	–
Total	119	0.0	214	1.9	238	7.6	59	1.7

[a] one old scar, 1 dead.
[b] one with old scar.
[c] two with old scars.

in June (1); July (3), October (4), and November (7). The differences in prevalence in 3-monthly periods are significant ($P<.01$) when tested for independence. The seasonal distribution of infections thus indicate an increased prevalence in the fall months. Similar seasonal trends in prevalence of cuterebrid larvae in *Peromyscus* have been reported for more northerly regions (Burt, 1940; Test and Test, 1943; Dalmat, 1943; Sealander, 1961; Wecker, 1962). The infection rate in Florida mouse populations is lower generally than those reported for *Peromyscus leucopus* by several authors (Test and Test, 1943; Dalmat, 1943; Scott and Snead, 1942; Hirth, 1959; Sealander, 1961, Abbott and Parsons, 1961; Wecker, 1962), a possible reason being that *P. leucopus* occurs more regularly in habitats favorable to *Cuterebra* than does P. *floridanus*.

F. *Leptospires*

No evidence of leptospire infections was obtained from four mice collected at one sand pine scrub station. This sample is far too small to give any indication of the true status of leptospires in this host.

G. *Protozoa*

Blood smears of 10 mice and fecal samples of 38 specimens were examined for parasites. All blood smears were negative. *Endamoeba ? muris* (Grassi), *Trichomonas ? muris* (Grassi), and *Giardia ? muris* (Grassi) were recorded in fecal preparations. *Endamoeba* occurred in 2 (7.1%) of 28 mice from which smears were made, *Trichomonas* in 17 (60.7%), and *Giardia* in 12 (42.8%). One young mouse had relatively large numbers of *Trichomonas* and *Giardia*, and the former was abundant in one adult female. According to Dr. Elliott Lesser, who made the examinations and determinations, the remainder of the mice had relatively light infections of these protozoans, with the incidence of *Endamoeba* being particularly low.

Preserved feces from 8 of 10 mice from scrub habitats contained parasitic protozoans. Two specimens had only *Trichomonas*, 4 only *Eimeria* sp. (oocysts), and 2 both.

H. *Helminths*

1. *Trematodes.*—The ova of an unidentified, apparently dicrocoeliid, fluke were recovered from livers subjected to the formalin-ether concentration technic. Although careful dissections of numbers of both fresh and preserved livers were made, no adult flukes were observed, or were recognizable fragments of adults found in the egg-containing sediments from treated livers.

The prevalence of this parasite, as indicated by the occurrence of ova in livers, was 7.0% in a sample of 723 mice from all habitats combined. Considering only populations from which infected specimens were recorded, the prevalence of infection was 15.0%. In these populations, 15.9% (50) of 315 adults were infected, as compared to 3.8% (1) of 26 young. Although suggestive of the existence of an age difference in infection rare, the difference is not statistically significant ($.10>P>.05$).

The correlation between habitat type and infection rate is high ($P<.01$). Forty-five (88.2%) of 51 infected mice were from upland hammock or pine flatwoods habitats (Table 11). The evidence for the restriction of infections to the moister of the habitat types utilized by Florida mice is strengthened by the fact that the one infected mouse recorded from sand pine scrub was collected in close proximity to a mesic hammock and that each of five infected animals from longleaf pine/turkey oak were from a live-trapping study area and had capture records showing that they ranged into the moister ecotone area between the turkey oak and an adjoining mesic hammock. The close correlation between the occurrence of the parasite and the moistness of the habitat is probably related to the ecological distribution of an intermediate molluscan host.

Infections were recorded in all months with the exception of May, August, and September. In those populations in which in-

TABLE 11.
Prevalence of unidentified trematode in different habitats based on presence of eggs in liver

Habitat	Number Examined	Percent Infected
Sand pine scrub	120	0.8[a]
Slash pine/ turkey oak	45	0.0
Longleaf pine/ turkey oak	246	2.0
Upland hammock	256	15.6
Pine flatwoods	56	8.9
Total	723	7.0

[a] captured near mesophytic hammock

fections were present, the mean prevalence was 15.9% for the January-March period, 30.9% for April-June, 18.0% for July-September, and 6.7 for October-December. The data are, therefore, suggestive of a tendency toward a higher frequency of infections in the warmer months of the year.

2. *Cestodes.*—Larval cestodes were rare, only 3 cases being recorded in over 700 specimens examined from all habitats. One mouse from longleaf pine/turkey oak had cysticerci of either *Cladotaenia* or *Paruterina* in the liver. The former is a parasite of hawks in the adult stage and the latter, a parasite of owls. One mouse from slash pine/turkey oak and another from sand pine scrub habitat about ½ mile away had *Taenia lyncis* Skinker cysticerci in the liver. Only one specimen was present in each case.

The only adult cestode recorded was *Hymenolepis ? nana* (Siebold). It occurred in 4.8% (9) of 186 mice examined from all habitats combined. Although the prevalence of infections was higher in adults (5.1%) than young (3.6%), the difference is not significant. The mean number of worms per infected host was 3.0, with a range of from 1 to 11. *Hymenolepis* was recorded in mice from all habitats, with the highest number of infections being encountered in sand pine scrub and upland hammock environments (Table 12). A seasonal trend in infections is suggested by the data. The highest prevalence during the year (12.0%) occurred during the January-March period. From April to June, 3.6% of the mice were infected. No infections were recorded in the July-September interval, and the prevalence in the October-December period was only 2.0%.

3. *Nematodes.*—Five species of nematodes were recorded. These included *Capillaria hepatica* (Bancroft), *Rictularia ?coloradensis* (Hall), *Aspiculuris americana* Erickson, *Syphacia peromysci* Harkema, and *Trichostrongylus ransomi* Dikmans.

The prevalence of *C. hepatica* infection in the livers of 723 mice from all habitats was 2.9% (Layne and Griffo, 1961). Considering only those populations in which infections were recorded, the prevalence was 12.7%. *Aspiculuris* occurred in 32.2% (60) of 186 mice examined from the four major habitats. The mean number of worms in infected hosts was 4.2 with a range of from 1 to 31. *Rictularia* occurred in 9.1% of the mice. The average number of worms in infected mice was 5.7, with extremes of 2 and 14. Harkema (1936) observed a higher prevalence rate for this parasite in *Peromyscus leucopus* in North Carolina, but usually found only single worms, rarely two, in infected hosts. *Syphacia* was present in 2.2% of the animals, averaging 2.2 worms per host. Only one mouse had more than one worm (6). One infection of *Trichostrongylus* was recorded, a prevalence of 0.5%, and only one individual was collected.

Seven of 84 mice infected with either *Hymenolepis, Rictularia, Aspiculuris, Syphacia,* or *Trichostrongylus* possessed more than one form. Three had both *Hymenolepis* and *Aspiculuris,* while single cases each were recorded for the following combinations: *Rictularia/Aspiculuris, Syphacia/Trichostrongylus,* and *Aspiculuris/Syphacia.*

A general trend of higher infection rates in adults as compared to young was noted in all nematodes for which adequate samples were available. *C. hepatica* occurred in 15.5% of the adults in infected populations and in only 2.8% of the young (Layne and Griffo, 1961). The prevalence of *Rictularia* in adults was 10.1% as compared to 3.6% in young. Corresponding values for *Aspiculuris* were 34.2 and 21.4%. These differences are statistically significant ($P<.05$) only in the case of *C. hepatica.*

TABLE 12.
Prevalence of five helminths in different habitat types

Habitat	Total No. Examined	Percent Infected	Hymenolepis	Rictularia	Aspiculuris	Syphacia	Trichostrongylus
			Percent infected	Percent infected	Percent infected	Percent infected	Percent infected
Sand pine scrub	45	48.9	8.9	35.6	11.1	0.0	0.0
Longleaf pine/ turkey oak	59	42.4	1.7	1.7	40.7	0.0	0.0
Upland hammock	52	48.1	5.7	0.0	44.2	0.0	0.0
Pine flatwoods	31	38.7	3.2	0.0	25.8	12.9	3.2

C. hepatica exhibited a marked habitat restriction, occurring only in mice from sand pine scrub and slash pine/turkey oak habitats (Layne and Griffo, 1961). The combined prevalence of five helminths of the alimentary tract was highest in sand pine scrub and upland hammock, lowest in pine flatwoods, and intermediate in longleaf pine/turkey oak (Table 12). When tested for independence, however, these differences are not statistically significant ($.80 > P > .70$). Of the other four nematode species, *Aspiculuris* had the greatest habitat range, showing greater abundance in mice from longleaf pine/turkey oak and upland hammock and less in sand pine scrub and pine flatwoods. *Rictularia* was the most prevalent nematode in sand pine scrub, occurring outside of this habitat only in longleaf pine/turkey oak, where it was infrequent. *Syphacia* and *Trichostrongylus* were recorded only in pine flatwoods.

Some suggestion of seasonal trends in prevalence is evident in the data for three of the nematodes. The prevalence of *C. hepatica* reached its highest level (9.8%) in the April-June period, declining to 3.0 and 2.4%, respectively, in the July-September and October-December samples. No infections were recorded in the January-March interval. In contrast, *Rictularia* and *Aspiculuris* were most prevalent in the January-March period. The former declined from 14.0% to 10.9% in the April-June interval. The lowest infection rate occurred in the July-September sample (3.2%), that for the October-December period being somewhat higher (6.0%). *Aspiculuris* infections dropped from 42.0% in the January-March sample to 30.9% in the April-June period. The prevalence of this parasite was 38.7% in the July-September interval and 20.0% in the October-December period.

I. *Pentastomids*

Nymphal stages of the pentastomid *Porocephalus crotali* (Humboldt) were found in 7 (0.8%) of 840 Florida mice examined. Apparently the occurrence of *P. crotali* nymphs in the Florida mouse constitutes the third record of this parasite in North American mammals. Penn (1942) reported its presence in the muskrat (*Ondatra zibethicus*) in Louisiana, and Self and McMurry (1948) recorded it from *Peromyscus leucopus* in Oklahoma.

All infections were in adult mice. In two specimens the parasites were partially embedded in the liver. One female had a nymph in the mesovarium and one in the bladder. A male had nymphs in the mesenteries of the epididymides, and a female had them in the mesenteries of the abdominal viscera and attached to the lung and liver. In the above instances the number of nymphs present was small, ranging from one to five in the cases where counts were made. Two mice were heavily infected. A female had numerous nymphs located on the liver, intestine, lungs, body wall, kidney, and bladder and in the mesenteries of the abdominal organs. A male had the nymphs beneath the tunica albuginea of the testes, around the cauda epididymis, in the trunk mesenteries, on the surface of the liver, and in the mesentery near the lung. None of the mice infected with *Porocephalus* exhibited any evidence of weakness or debilitation when alive nor any gross effects of the parasites when necropsied. Esslinger (1962) found that the tissue responses of the liver of the rat to immature stages of *Porocephalus* resembled those produced by other agents of visceral larva migrans and metazoan parasites generally.

Of the 840 mice examined for *Porocephalus,* 202 were from sand pine scrub habitats, 49 from slash pine/turkey oak, 300 from longleaf pine/turkey oak, 230 from upland hammock, and 60 from pine flatwoods. Infections occurred only at a single scrub station. Here, 103 adults and 11 young mice were collected, giving a prevalence of *Porocephalus* in this population of 6.1% for both age groups combined or 6.8% for adults. The difference in infection rate of adult males and females was not significant on the basis of the small sample involved.

The scrub station from which pentastomids were recorded was a slight ridge surrounded by low pine flatwoods, marshes, and cypress swamps. There was evidence of a high snake population at this locality, and such semi-aquatic forms as the cottonmouth (*Agkistrodon piscivorus*) and water snake (*Natrix fasciata*) were recorded. Possibly, therefore, the occurrence of *Porocephalus* at this station was in part due to an abundance of snakes. However, additional factors probably were involved, since certain other scrub stations as well as those

in other habitat types appeared to support high snake populations while *Porocephalus* was apparently absent.

Twelve mice collected in February were free of infections. Three of 59 specimens taken in April (11), and May (48) were infected, as were 3 of 30 specimens from July (5) and August (25). Of 11 specimens examined in October (6) and November (5), 1 had a *Porocephalus* infection. Thus, although the data are not conclusive, a slight trend toward a higher frequency of infections in late summer and fall is indicated. Whether this trend is related to the life cycle of the parasite or to seasonal differences in the movements or behavior patterns of mice or snakes is uncertain.

V. Discussion

Thirty-two parasites, including 18 ectoparasites and 14 endoparasites, were recorded from the Florida mouse. Although further collecting may yield additional forms, particularly microorganisms and helminths, the present list probably is a relatively complete representation of the parasitic fauna of this rodent. Comparative data for other small mammals are few. However, Elton *et al.* (1931) found 41 species of parasites associated with the wood mouse (*Apodemus sylvaticus*) in England.

Based on combined data for all localities, habitats, and seasons, the overall level of parasitism on the Florida mouse is low. The prevalence of ectoparasites as a group considerably exceeds that of endoparasites. The difference is especially pronounced if Protozoa are excluded from consideration. A number of the parasites recorded were rare in all habitats or occurred with any frequency only in particular habitat types. Of the seven categories of ectoparasites recognized for the purpose of analysis, only non-infesting trombiculids, non-trombiculid mites, ticks, and fleas occurred on more than 5% of the mice in the total sample. In each of these groups, only one or two species dominated in the identified samples. These included the mites *Trombicula crossleyi*, *Euschongastia peromysci*, and *Haemolaelaps glasgowi*, the tick *Dermacentor variabilis*, and the flea *Polygenis floridanus*. Two of the ectoparasitic species collected, *Hoplopleura hirsuta* and *Hoplopsyllus affinis*, were clearly accidental. In the case of endoparasites, *Endamoeba*, *Giardia*, *Trichomonas*, *Eimeria*, an unidentified trematode, *Hymenolepis ?nana*, and *Aspiculuris americana* approached or exceeded the 5% prevalence level. Thus, even with the rather liberal criterion of commonness accepted here, only 12 of the 32 parasites of the Florida mouse would be considered as generally common. Roughly the same proportion, 13 out of 41 species, of the parasites of the wood mouse was considered to be of possible importance in the study by Elton *et al.* (1931).

Parasitism apparently plays a relatively minor role in the population dynamics of the Florida mouse. There is no evidence to indicate that parasites constitute an important source of direct mortality. In addition to the generally low prevalence rates, the numbers of ecto- or endoparasites carried by individual hosts were seldom high for the particular parasite involved. Nor was any animal encountered during the course of the study in a sick or weakened state that could be attributed to its parasite load, although the possibility that sick or weak mice may be less responsive to traps must be considered. However, in some cases even relatively low parasite burdens probably may produce effects on the host's physiology or behavior that render the animal more susceptible to predation or various environmental stresses. At the general levels of abundance of parasites found in this study, endoparasites would probably be more important in this regard than ectoparasites. Certain ectoparasites without an obvious direct effect on the host also may be involved in inter- and intra-specific transmission of bacterial or viral diseases that may produce debilitation or death, although no evidence for this is as yet available for *Peromyscus floridanus*.

Although the overall parasite level of the Florida mouse is low, the actual combinations of parasitic species and prevalence rates in different host populations are far from uniform. Differences in patterns of parasitism may be related to such factors as age of host, host density, habitat, and season and are of interest from the standpoint of their causation as well as their significance in terms of the biology of the host. Adult mice appear to carry more parasites than young. However, a marked difference in the effect of host age on prevalence exists between ecto- and endoparasites. The average prevalence of ectoparasites was 24.4%

on adult mice and 21.8% on young. For those endoparasites (unidentified trematode, *Hymenolepis, Capillaria, Rictularia, Aspiculuris,* and *Porocephalus*) for which adequate data for a comparison of age-specific infection rates were available, mean prevalence was 14.6% in adult and 5.9% in young mice.

Several factors might contribute to the greater difference in age-specific prevalence of endoparasites compared to ectoparasites. One of these is the relative mobility of the infective stages of the two kinds of parasites. Most of the ectoparasites have a relatively mobile, free-living infective stage, in contrast to that of endoparasites which is typically an ovum, cyst, or essentially sedentary larval stage. A young mouse outside its burrow thus would have a higher probability of encountering an ectoparasitic organism than an endoparasitic one, consequently acquiring a population of the former more rapidly than the latter.

The extent to which parasites are acquired in the nest might also have a bearing on the problem of the different age relationships in prevalence of ecto- and endoparasites. Infestation in the natal nest might be expected to contribute significantly to a faster build up on the young mouse of those ectoparasites (non-trombiculid mites and fleas) which require the host's nest for at least part of the life cycle. The present data, however, do not indicate any trend toward higher prevalence of these forms than of those ectoparasites in which infestations are probably ordinarily acquired outside the nest. This may be due to the fact that most of the young in the samples were of post-weaning age and might, therefore, have already moved from the natal burrow and established their own nests, in which mite and flea populations had not yet had sufficient time to build up. Drummond (1957) showed that the nesting activity of white-footed mice (*Peromyscus leucopus*) was a particularly important influence on the fluctuations in numbers of species and individuals of mites in nests.

Circumstantial evidence suggests that nests may not be an important source of endoparasitic infections in the Florida mouse. The low prevalence of endoparasites in young might in itself be cited in support of this. Some endoparasites also exhibit distinct trends in prevalence associated with habitat type, which suggests that physical environmental factors outside the nest may be influencing the distribution of the parasites in question. Furthermore, if fecal contamination is assumed to be a principal route of nest infections, then the fact that the Florida mouse appears to practice good nest sanitation would perhaps also serve to limit the incidence of nest-acquired infections. No accumulations of feces were found in two nests excavated, and captive mice generally defecated in parts of the cages removed from the nest. Another factor that might contribute to a lower rate of endoparasitic infections in young mice in the natal nest is the existence of some degree of immunity.

A final possibility is that the difference in age-specific prevalence rates of the two major groups of parasites is actually partly or entirely due to the age classification used. In ectoparasites, excepting botflies, an infestation presumably is recognizable as soon as it occurs, whereas there may be a variable period between the acquisition of the infective stage of an endoparasite and the time at which the infection would be apparent at necropsy. Since the average interval a mouse spends in the young age class is considerably shorter than that spent in the adult category, it follows that a significant proportion of infections acquired by young mice may not reach a stage at which they would be detected at routine autopsy until the animals have passed over into the adult age group. Therefore, the actual numbers of endoparasites carried by young mice may have been appreciably greater than observed. Unfortunately, the present data do not permit any conclusions as to the relative importance of the above-mentioned factors, either singly or in combination, in explaining the differences noted. Whatever the cause, the lighter parasite load, particularly of endoparasites, of young mice is of significance from the standpoint of population dynamics in that it can be assumed to contribute to better survival of this age class.

Comparisons of prevalence rates of five groups of ectoparasites at different host population levels showed no overall effect of population density on the proportion of mice infested. In going from a lower to a high population level, decreases in prevalence averaged 42.2% and increases, 46.6%. The number of instances in which no change

occurred averaged 10.4%. The mean decrease in prevalence was 22.1% and the average increase, 27.4%. Because of the small number of comparisons available, trends in individual habitats cannot be considered conclusive. However, sand pine scrub differed from other habitat types in showing a stronger correlation between ectoparasite prevalence and host abundance.

The relationship between host population level and parasite prevalence varies between different types of ectoparasites. The data for fleas and mites indicate a positive correlation between host abundance and parasite levels, while an inverse relationship is suggested in the case of ticks and botflies. The prevalence of fleas shows the strongest association with host numbers of any group of ectoparasites. This trend is largely due to the species *Polygenis floridanus,* which thus far is known only from the Florida mouse. The ultimate factor responsible for this narrow host restriction may be microclimate of the nest of *Peromyscus floridanus,* although several proximate factors also may operate to prevent host transfer (Johnson and Layne, 1961).

In view of this host specificity, the numbers of *Polygenis floridanus* would be expected to conform more closely to the population level of the Florida mouse than those of other ectoparasites which have a broader host range. The relationship between prevalence of mites and host population level was considerably less pronounced than in the case of Siphonaptera. The prevalence of nontrombiculid mites on a particular small mammal species appears to depend at least in part on the abundance of other possible hosts in the same habitat. The Florida mouse was the principal small mammal species at many of the stations sampled during this study, which might explain the apparent correlation between mouse and mite population trends. As chiggers are parasitic only in the larval stage and do not require the nest environment to complete their life cycle, the correlation, though slight, between their prevalence and mouse density may be due to a certain degree of host specificity in the commoner species such as *Trombicula crossleyi.* The particular habits or relative abundance of the Florida mouse in the habitats studied may also be factors influencing the host density correlated abundance of chiggers.

Botflies and ticks have a low infestation rate on the Florida mouse, usually occurring as one or only a few individuals. They do not require the nest for their life cycle, although ticks may seek refuge in the nest (Drummond, 1957). The inverse relationship between the prevalence of these parasites and mouse abundance suggested by the data might be taken to indicate an effect of the parasite on host population. An alternative explanation which assumes a limited number of parasites so that an increase in host density results in reduced frequency of infestations seems more likely. Two factors might operate to prevent an increase of parasites, after an appropriate lag, with an expanding mouse population: (1) a limitation on the numbers of parasites in certain habitats by environmental factors (physical or biotic) independent of the number of mice present; (2) the existence of marked, short-term fluctuations in host populations that even in an environment with an otherwise high carrying capacity for the particular parasites would inhibit a build-up of parasite numbers. Elton *et al.* (1931) advanced a similar explanation for the inverse relationship between wood mouse population density and certain endoparasites.

Of the factors considered in this study, habitat is probably the most important in determining the patterns of parasitism in particular host populations. The average prevalence of ectoparasites was lowest in sand pine scrub (22.2%), slightly higher in flatwoods (22.5%) and longleaf pine/turkey oak (24.4%), and highest in upland hammock (27.1%). The data on prevalence of ectoparasites in flatwoods are probably biased by the fact that samples were available for this habitat type only in the early part of the year, while all seasons are represented in the remaining habitats. Since there is evidence that in such groups as trombiculid mites, ticks, and botflies greatest prevalence occurs in late summer, fall, and early winter, it is possible that the overall ectoparasite prevalence in flatwoods is actually higher than indicated by the available data. On the other hand, the marked fluctuations of soil moisture in this habitat may be detrimental to some types of parasites.

The abundance of ectoparasites as a group apparently is correlated with the moistness

of the habitat and development of ground cover and litter. This trend is particularly clear for ear-infesting chiggers and non-trombiculid mites and present, though less obvious, in ticks and botflies. Fleas are the only group of ectoparasites exhibiting a reverse trend, being more abundant in sand pine scrub and longleaf pine/turkey oak habitats. This habitat distribution pattern primarily reflects that of *Polygenis floridanus*.

No obvious correlation exists between the prevalence of endoparasites as a group and common environmental factors such as moisture or ground cover. Sand pine scrub had the highest average infection rate (9.7%), longleaf pine/turkey oak the lowest (5.8%), and upland hammock and flatwoods occupied intermediate positions with rates of 8.2 and 6.8%, respectively. Individual parasite species, however, did show distinct trends in abundance correlated with habitat type. This suggests that the various kinds of endoparasites are more variable in their environmental requirements than the ectoparasitic forms and may thus exhibit greater habitat restriction. Other evidence points to the existence of narrower habitat specificity of endoparasites as compared to ectoparasites. Only 4 (24%) of 17 species of ectoparasites were collected from a single habitat, whereas 6 (60%) of 10 macroendoparasites are in this category. If the similarities (presence or absence of species) in total parasite faunas are analyzed, sand pine scrub agrees with other habitat types in an average of 54% of the parasites. Longleaf pine/turkey oak exhibits a 58% agreement, upland hammock 66%, and flatwoods, 57%. The differences, though slight, suggest that variation in species composition as well as in prevalence of large groups is associated with habitat differences. When the habitat similarities are determined separately for ecto- and endoparasites, a difference in habitat tolerance is indicated for the two groups. The average similarity in species composition of ectoparasites between different habitat types is slightly higher (61%) and the range of values for individual habitats less variable (57-65%) than for endoparasites, for which corresponding figures are 57% and 47-67%, respectively. On the basis of its endoparasitic fauna, scrub is again more distinctive than other habitats. Sand pine scrub is also the only habitat type in which the prevalence of parasites with an egg as the infective stage greatly exceeds those with free-living larvae. This suggests that high soil temperatures and dry conditions may limit the success of parasites with free-living larval stages in the scrub habitat.

The extent to which new species of ecto- and endoparasites are added as the habitat range is increased is shown in Figure 3. The data for this graph were obtained by systematically varying the sequence of the four principal habitats involved in the study and determining the mean percentage of the total species of parasites added with the addition of each habitat. The results seem to indicate that for any single habitat a higher proportion of the ectoparasite fauna is represented than of endoparasites and as a consequence the rate at which new species are added per habitat is higher in the latter. This again supports the supposition that the ectoparasites of the Florida mouse tend to show less habitat restriction than endoparasites.

The above data demonstrate clearly that populations of the Florida mouse living in different habitats are subjected to different regimens of parasite pressure, and that certain parasites of negligible significance over

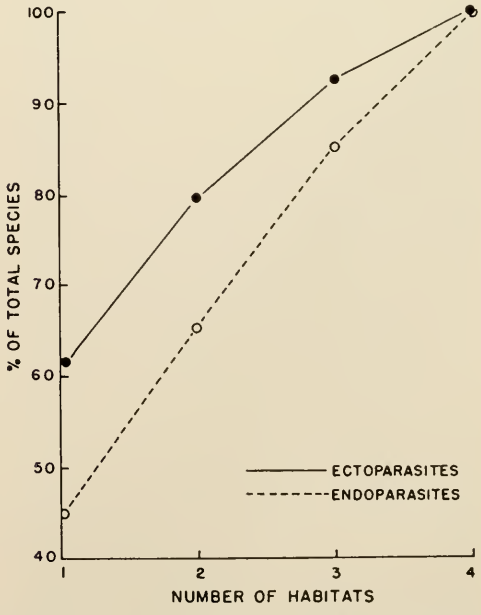

Figure 3. A comparison of the increase of ecto- and endoparasite species on the Florida mouse with increase in habitat types.

the entire geographic and ecologic range of the species as a whole may be of some local importance. This provides an example of the variation in selective forces that may operate on populations of a species in different habitats and influence its ability to invade new environments.

Both the overall prevalence and abundance of particular groups of ecto- and endoparasites are influenced by season. The highest prevalence of ectoparasites as a group occurs in the late fall and early winter (27.8%) and declines to the lowest level in the April-June interval (20.9%). Individual groups show varying degrees of departure from this general pattern. The peak prevalence of endoparasite infections falls in the January-March interval (14.0%) and exhibits a general decline through the year, reaching the lowest point in the October-December period (7.7%). The causes of these trends may be different in the two groups of parasites. The general pattern in ectoparasites is probably attributable mainly to the direct effects of weather on the life cycles of the parasites, particularly in the case of chiggers, ticks, and botflies. In other groups, such as non-trombiculid mites and fleas, seasonal trends may be influenced by variation in the nesting habits or activity of the hosts. Two factors may be important in explaining the seasonal patterns of general endoparasite abundance. The peak levels occur in that part of the year when the food supply of the mice appears to be most limited. The mice may forage more intensively and do more digging for food at this time and as a consequence have a higher probability of acquiring an infection than at other seasons. The other factor concerns a change in the age composition of populations during the year. Much of the breeding of the Florida mouse is concentrated in the late fall and early winter. Thus when reproduction has been successful, young age groups predominate in the population. The observed differential in adult and young infections noted earlier could therefore account for at least a part of the fall and winter decline in infection rate. Elton *et al.* (1931) attributed seasonal changes in the frequency of the nematode *Nematospiroideas dubius* in the wood mouse to changes in host age composition. Additional factors may be involved in the trends shown by particular parasites, for example, the unidentified trematode and *Porocephalus,* in which seasonal changes in the habits or activity of intermediate or definitive hosts might in turn influence the prevalence of infections in mice.

The influence of seasonal changes in parasite prevalence on the host probably is greater in the case of endoparasites than ectoparasites. As noted previously, at the general levels of abundance shown by the two groups, endoparasites probably would be expected to have more effect on the health of the host than ectoparasites, assuming that none of the ectoparasites recorded transmits some as yet unknown viral or bacterial disease that causes significant mortality. In addition, the annual peak in endoparasite burden coincides with the time of year in which populations appear to be under greatest stress from other environmental factors, particularly low temperatures and food shortage.

VI. Summary

Data on the parasites of the Florida mouse, *Peromyscus floridanus,* were obtained from 35 localities during the period February, 1957, to October, 1960. Samples of from 542 to 610 mice were surveyed for different kinds of ectoparasites, while the numbers of specimens examined for various groups of endoparasites ranged from 4 to 840. Where adequate data were available, analyses were made to determine the influence of sex, age, and density of host, habitat, and season on parasite composition and prevalence.

Thirty-two species of parasites were recorded, only 12 of which were of relatively common occurrence from the standpoint of the species as a whole. Ectoparasites as a group were more abundant than endoparasites. Overall infestation rates for the former ranged from 69.3% for trombiculid mites in the ear canal to 0.2% for lice. Protozoans were the most frequent endoparasites (42.0%), larval cestodes the rarest (>.4%). In addition to generally low prevalence rates for various kinds of ecto- and endoparasites, the numbers of parasites carried by individual hosts were seldom high for the particular parasite involved. No evidence of mortality or weakening of mice attributable to parasites was obtained, and it is concluded that parasites probably play a relatively minor role in the ecology of the Florida mouse, although in some populations para-

sitism may be of more significance than in others.

The mean prevalence of six groups of ectoparasites on adult mice was 24.4% as compared to 21.8% on young. Age differences in prevalence were more pronounced in the case of endoparasites. Six species had a mean prevalence of 14.6% in adults and 5.9% in young. The lighter parasite load, particularly of endoparasites, of young mice probably favors a higher survival rate in this age class and is therefore of significance from the standpoint of the population dynamics of the host.

No general correlation between overall ectoparasite abundance and host numbers was demonstrated, certain groups appearing to exhibit a tendency to increase in prevalence with increase in host density and others showing a reverse trend. The most marked positive correlation between prevalence of a parasite and host numbers was shown by fleas. This relationship is presumed to reflect the intimate association between the Florida mouse and the flea *Polygenis floridanus*, which appears to be restricted to this host. The prevalence of ticks and botflies may vary inversely with host abundance. If actual, this trend might indicate that in the habitats studied these parasites are held at relatively low levels of abundance by factors not directly related to the Florida mouse or that short-term fluctuations in the small mammal populations in these habitats prevent an increase in their numbers.

Of the host and environmental factors considered in this study, habitat exerted the strongest effect on parasite composition and abundance. Among ectoparasites, mites, ticks, and botflies tended toward greater abundance in moister woodlands with greater development of ground cover and litter layer, while fleas were the only group showing greatest prevalence in drier habitat types. No overall correlation between endoparasites as a group and habitat type was apparent, although individual species exhibited strong variation in habitat-specific prevalence.

Prevalence of ectoparasites as a group was highest in late fall and early winter. Individual kinds departed from this overall trend to varying degrees. Endoparasites as a group were most abundant from January through March. The trends in ectoparasite abundance are probably mainly correlated with seasonal changes in physical environmental factors. The peak in endoparasite abundance may be related to greater foraging activity of mice during a time of food scarcity or to variation in age composition of populations. The influence of seasonal changes in parasite pressure on the host is probably greater in the case of endoparasites than ectoparasites, since the heaviest endoparasite burden corresponds with the period of the year in which mouse populations may be under greatest stress.

VII. Acknowledgments

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ABSTRACT

Thirty-two species of parasites, including 18 ectoparasites and 14 endoparasites, were recorded from the Florida mouse, *Peromyscus floridanus*. Only 12 species had a prevalence equalling or exceeding 5% in the total samples of mice examined. The present data include that, for the species as a whole, parasitism is not a major factor in the ecology of the Florida mouse and probably has little direct role in the regulation of population size. Although the overall level of parasitism is relatively low, conspicuous differences in the kinds and abundance of parasites may occur between populations. Age composition and density of the host populations, habitat, and season are shown to be among the factors influencing patterns of parasite distribution and abundance on *P. floridanus*.

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THE SPONGE FAUNA OF THE ST. GEORGE'S SOUND, APALACHEE BAY, AND PANAMA CITY REGIONS OF THE FLORIDA GULF COAST[1]

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I. Introduction

The sponge populations of the Gulf of Mexico have been little investigated although the western coast of Florida harbors a commercial sponge fauna second only to that of the eastern Mediterranean (de Laubenfels, 1948). The commercial sponge fisheries of this country are centered in the Gulf.

Although sponges have been exploited for years, only two studies on the general sponge fauna of this area have been published. Carter (1884) listed tentative genera and a few species collected along the West Coast of Florida. These names were based on dry, fragmental specimens. De Laubenfels (1953a) reported on a collection of sponges made by the staff of the University of Miami Marine Laboratory in the eastern Gulf of Mexico in 1948. In his study, data from twenty-two stations were reported from the western coast of Florida in the area between the Dry Tortugas and Dog Island, to the west of Apalachee Bay. Three stations were occupied in the Apalachee Bay region and the results from these stations (de Laubenfels, 1953a) have been included in this paper.

The purpose of the present investigation was to survey the sponge fauna of the Apalachee Bay Region. This involved extensive collecting from stations in the area over a period of two years. In addition, specimens were obtained from Dr. John Morrill who made collections in the St. Mark's Light area in 1955.

The initiation of a detailed faunal investigation of the Panama City, Florida, area by the staff of the Oceanographic Institute, Florida State University, made possible the addition of several specimens from that vicinity for comparison. Some notes on the ecology of the sponge fauna are included.

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II. Collecting Stations

In Fig. 1 are located the collecting stations in the Apalachee Bay - St. George's Sound area including 14 occupied by the author and associates in 1956 and 1957 and three occupied by the University of Miami in 1948 (de Laubenfels, 1953a). Station depths are indicated in Fig. 1. Station 15, Panama City, was under investigation by Dr. Meredith Jones of the Oceanographic Institute, Florida State University, in 1959. A large part of his collections was obtained by dredging, the remainder by hand. Descriptions of the stations follow:

Station 1.—29°55′36″ N., 84°26′30″ W. Depth: 1.5-3.5 meters. Substrate: primarily outcrops of Tampa limestome; much open sandy bottom as well.

Station 2.—29°54′18″ N., 84°26′ W. Depth: 1 meter; intertidal in places. Substrate: chiefly sand; broken shells or other invertebrates serve as substrates for some species of sponges.

Station 3.—29°54′30″ N., 84°23′-84°24′ W. Depth: 1 meter; intertidal in places. Substrate: chiefly oyster bars in the area; some clear areas of sand and mud.

Station 4.—29°47′06″-29°48′ N., 84°19′ 30″ W. Depth: 10-14 meters. Substrate: rock and sand.

Station 5.—29°49′44″ N., 84°16′18″ W. Depth: 12 meters. Substrate: sand.

Station 6.—29°51′ N., 84°11′24″ W. Depth: 8 meters. Substrate: sand.

Station 7.—29°49′30″-29°49′48″ N., 84° 07′31″-84°08′ W. Depth: 9.5 meters. Substrate: rock and sand.

Station 8.—30°05′ N., 84°11′30″ W. Depth: intertidal on bar, 2-3 meters in channel south of bar. Substrate: oyster bar, mud and sand in channel south of bar.

Station 9.—30°04′30″ N., 84°11′ W. Depth: 1 meter. Substrate: sand and *Thalassia testudinum* Konig.

Station 10.—30°03′ N., 84°05′ W. Depth: 2.5-3.5 meters. Substrate: Tampa

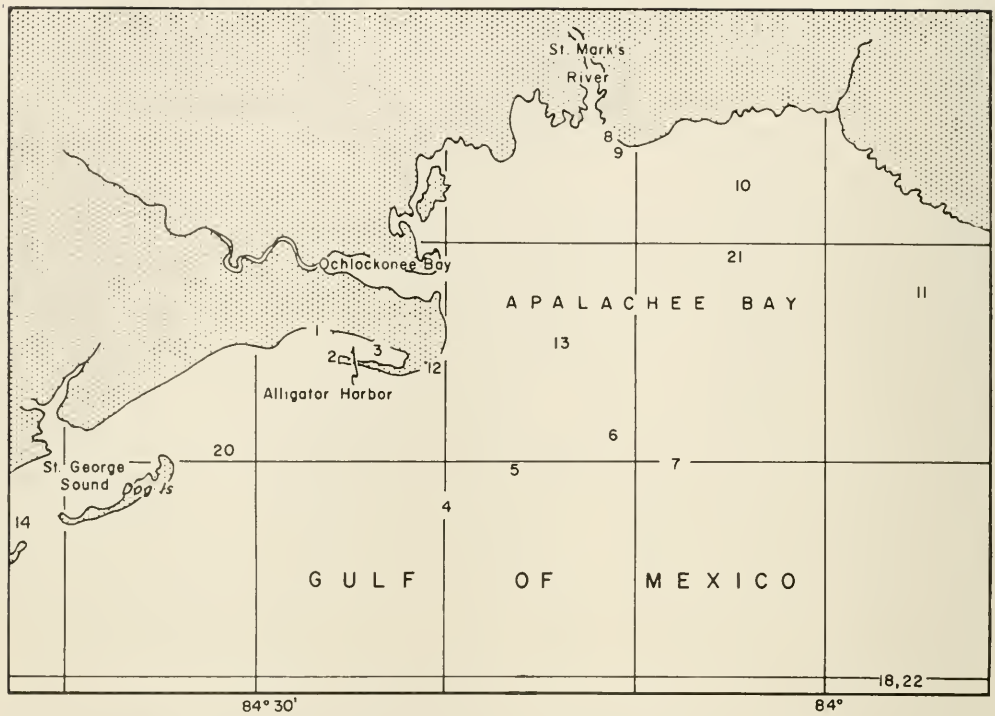


Figure 1. Map of the Apalachee Bay region, showing stations (drawn by Dr. Stuart Grossman, Institute of Marine Science, Port Aransas, Texas).

limestone outcrops in the sandy *Thalassia* grass flat.

Station 11.—29°57′30″-29°58′ N., 83° 55′-83°56′ W. Depth: 2.5 meters. Substrate: primarily sand and *Thalassia* grass flat. Some limestone outcrops occur.

Station 12.—29°53′56″ N., 84°20′-84°21′ W. Depth: 0 to 1 meter. Substrate: Beach. *Note:* Specimens from this station probably come from a sponge bed located approximately 29°56′ N., 84°15′ W., according to local residents.

Station 13.—29°55′18″ N., 84°14′12″ W. Depth: 5.5-6.5 meters. Substrate: predominantly muddy.

Station 14.—29°46′45″ N., 84°42′12″ W., Depth: 6 meters. Substrate: sand and/or mud.

Station 15.—This includes the entire Panama City area of the north Florida Gulf Coast, both offshore and estuarine areas.

University of Miami Stations.—October, 1948 (de Laubenfels, 1953a).

Station 20.—29°50′ N., 84°32′ W. Depth: 12.5 meters. Substrate: not indicated.

Station 21.—29°59′ N., 84°05′ W. Depth: 6.5 meters. Substrate: not indicated.

Stations 18, 22.—29°39′ N., 83°56′ W. Depth: 14-14.5 meters. Substrate: not indicated.

III. Methods

Wading, skin-diving with face-mask and swim-fins, dredging, and beachcombing were employed in the collection of specimens from the areas investigated.

Upon collection, fresh specimens were fixed immediately in ninety-five per cent isopropyl alcohol, since delay causes physiological and physical distortion, especially of the flagellate chambers (de Laubenfels, personal communication). The original alcohol was decanted and replaced with seventy per cent isopropyl alcohol after an hour.

Fixation and storage in formalin were avoided since these procedures eventually reduce the sponge to a gummy mass. Neutral formalin fixation (for histological purposes) may be used providing the specimen is soon placed in at least two changes of seventy per cent alcohol to remove any traces

of the formalin (de Laubenfels, personal communication).

Hand sections were cut and mounted after the method of de Laubenfels (1953b). Paraffin mounts and microtome sections were made on most specimens. After the paraffin was removed by xylene, the section on the slide was removed from the xylene, blotted, and treated in the same manner as hand-cut sections. Spicule mounts of specimens with siliceous spicules were prepared according to the method of de Laubenfels (1953b). Sponges with a cortex, a special dermal skeleton, or a dermal membrane required spicule mounts from both this outer area and the endosome. Differences in the spicule populations of ectosome and endosome often are significant taxonomic characters. Mounts of boring sponge spicules were made by the method of Old (1941). Spicule mounts of calcareous sponges were prepared in much the same manner as those of boring sponges, except that concentrated potassium hydroxide solution was substituted for the nitric acid. This more tedious method was used since the normal spicule mounting procedure of de Laubenfels (using KOH instead of HNO_3) always leaves a thick coating of white substance on the slide which renders observation difficult.

Measurements of mean size and range of spicules were based on not less than 10 (usually 20) spicules of each category. Some data are expressed in a formula: *i.e.* Lower limit-mean-upper limit (length) $\times$ lower limit-mean-upper limit (diameter).

IV. Systematics

Sixty-four species, in 48 genera, are included here. Of these, 56 species, in 41 genera, were found during the course of this investigation. The remainder were recorded only by de Laubenfels (1953a). None belong to the class Hexactinellida; but the Calcarea and Demospongiae are well represented.

The classification of de Laubenfels (1936a) is followed. All specimens have been assigned Oceanographic Institute, Florida State University, numbers designated by "OI". Duplicate specimens have been deposited with the United States National Museum and are referred to by USNM numbers.

CLASS DEMOSPONGIAE

Order Keratosa Bowerbank

Family Spongiidae Gray

Spongia barbara Duchassaing and Michelotti, 1864.—The commercial "yellow sponge" was taken at Station 21 in October, 1948 and reported as *S. zimmocca barbara* by de Laubenfels (1953a). It was later restored to specific rank in a paper published shortly after his death (de Laubenfels and Storr, 1958).

Spongia graminea Hyatt, 1877.—The well known species known as the "Key grass sponge" (de Laubenfels and Storr, 1958) was taken at Station 21 and reported by de Laubenfels (1953a).

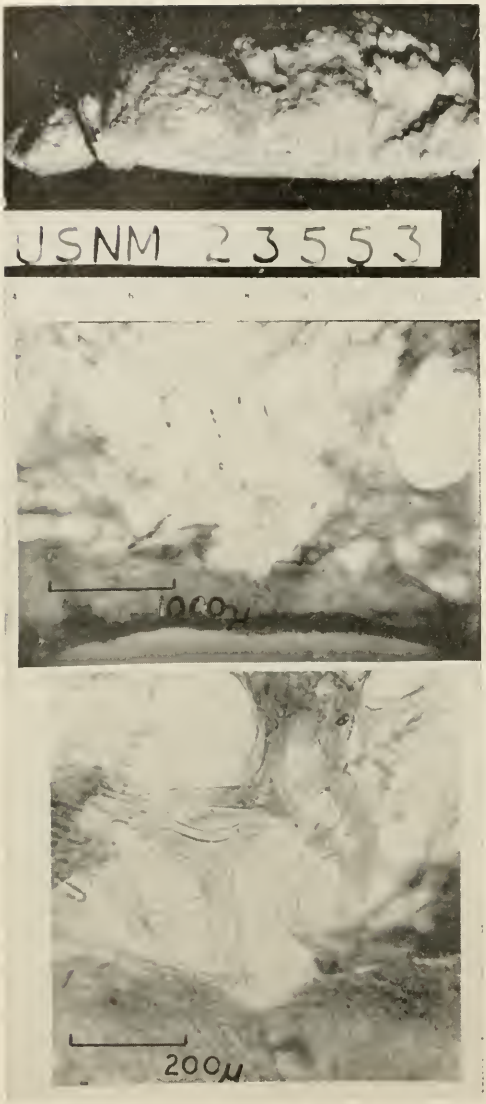
Spongia sp. (?).—OI 1052, USNM 23553, USNM 23558 (figs. 2-4). Specimens fitting closely the published description of the "Gulf grass sponge," *Spongia graminea tampa* de Laubenfels and Storr 1958 (page 110), were abundant at Stations 1 and 10. Depth was between 1.5 and 3.5 meters, and the sponges were found on a rock substrate.

These specimens also fit the written description of the "glove or finger sponge," *S. cheiris* reported by de Laubenfels and Storr 1958 (page 112), who found *S. cheiris* at Alligator Harbor, Florida. This report stems from specimens taken at Station 1 in the presence of de Laubenfels and later macerated, dried and sent to him by the author. Dr. de Laubenfels identified the sponge as the "glove sponge" in the field at the time of collection.

All this would lead to the conclusion that these specimens were indeed representative of *S. cheiris*. Unfortunately the specimens resemble the type specimens of *S. graminea tampa*, while the type specimen of *S. cheiris* seems close to, if not identical with, Hyatt's type specimen of *S. graminea*.

In addition there is the matter of color. *S. graminea tampa* is reported to be drab to pale taupe in color, whereas *S. cheiris* is black as is *S. graminea*. The author's specimens in life were white with faint lavender tints.

Dr. Willard Hartman of the Yale Peabody Museum feels that *S. cheiris* de Laubenfels and Storr is identical with *S. graminea* Hyatt and that *S. graminea tampa* de Laubenfels and Storr may indeed be a separate species (personal communication).



Figures 2-4. **2** (top). *Spongia* sp. (USNM 23553). **3** (middle). *Spongia* sp. section. **4** (bottom). *Spongia* sp. section.

Hippiospongia lachne de Laubenfels, 1936.—The "sheepswool sponge" of commerce was taken at Stations 18 and 22, and reported by de Laubenfels (1953a).

Hippiospongia gossypina (Duchassaing and Michelotti, 1864).—The "velvet sponge" is recorded only at Station 22 (de Laubenfels, 1953a).

Aulena columbia de Laubenfels, 1937.—The third report and the only record for the area is by de Laubenfels (1953a) from Station 20.

Ircinia fasciculata (Pallas, 1766).—OI 1000 and USNM 23556. The "stinker or garlic sponge" has the peculiar sulfurous odor characteristic of all species of *Ircinia.* The filaments, which are characteristic of the genus, had a mean diameter of 3.7 μ and ranged from 2 to 5.5 μ in diameter. The bulbs at the terminal ends of the filaments averaged 9.8 μ in diameter, with a range from 8.6 to 12.1 μ.

This sponge may be distinguished from all other members of the genus, except *I. ramosa,* by its brownish-white color. Also, its conules are much closer together than those of any other Floridian species in the genus except *I. ramosa.* The shape is variable, from massive to lobate and even occasionally ramose. In ramose specimens the branch ends tend to be pointed rather than bluntly rounded as in *I. ramosa* (de Laubenfels, 1950a).

The "garlic sponge" was extremely abundant throughout the year, usually on rock substrates at a depth of 2 to 15 meters. It was taken at Stations 1, 2, 10, 11, 12, 20, and 22. In addition it was found at Panama City, Florida, *i.e.* Station 15, on buoys.

Ircinia ramosa (Keller, 1889) de Laubenfels, 1948.—USNM 23689. One beachworn, macerated specimen was found at Station 12 on September 25, 1956, shortly after a heavy storm. It was preserved in dry condition.

The specimen was quite ramose, and had the characteristic bluntly rounded branch ends of the species, rather than pointed branch ends as in *I. fasciculata* (de Laubenfels, 1950a; Hartman, 1955). The branches were relatively broad, though flattened. At its widest point one branch measured 4.3 x 1.2 cm. Another branch was more rounded but still appeared slightly flattened; it measured 2 x 1.6 cm.

The surface was conulose with conules 1 to 2 mm high and averaging 2.2 mm apart, with a range of 1 to 4 mm. Oscules were scattered at random over the surface and were between 0.5 and 4 mm in diameter.

Filaments characteristic of the genus appeared abundantly. Although the mean sizes of the filaments and their tylote ends were not different from those of *I. fasciculata,* the size range in *I. ramosa* is distinctly smaller. Filaments of this specimen ranged from

2 to 4.4 μ in diameter, with a mean of 3.6 μ. The knobbed ends ranged from 4.4 to 9.9 μ, with a mean of 8.3 μ. The top figures of these ranges are distinctly smaller than those of the local specimens of *I. fasciculata* recorded here.

Ircinia campana (Lamarck, 1814) de Laubenfels, 1948.—OI 1006 and USNM 23579. This is the vase-shaped *Ircinia* with conules of medium size, 4 to 8 mm apart (de Laubenfels, 1936a, 1953a). It is reported to have a somewhat reddish color.

A specimen was taken at Station 20 and reported by de Laubenfels (1953a).

Specimens were taken at Stations 1, 4, 10, and 12 during the course of this investigation. Depth, in Apalachee Bay, ranged between 1.5 and 12.5 meters, and substrate was rock or sand. Specimens were basically white in color with overtones of pink, giving the flesh almost the color of Caucasian skin. The conules were about 1 mm high and only 2 to 4 mm apart. Flagellate chambers were hemispherical and small, with a mean diameter of 38 μ and a range from 27 to 46 μ.

The filaments of this species have been reported as 3 to 4 μ in diameter (de Laubenfels, 1936a) or 10 to 14 μ in diameter (Lendenfeld, 1888). The Apalachee Bay area specimens fall close to de Laubenfels' measurements. Filaments proper averaged 4 μ in diameter, range 2.2 to 4.8 μ, while the bulbous endings averaged 9.7 μ in diameter with a range from 8.6 to 11.4 μ. The filaments became distinctly narrower close to the bulbous ending. These narrower areas averaged 2.6 μ and ranged from 1.8 to 4 μ in diameter.

Ircinia strobilina (Lamarck, 1816) de Laubenfels, 1948.—OI 1040, USNM 23573. This is a cake-shaped *Ircinia.* Its coloration is reported to vary from dark grey to black and its conules are 6 to 12 mm apart (de Laubenfels 1936a, 1948). It was taken from a sunken ship off Panama City, Florida, depth 12.5 meters, substrate iron. The specimen is a flat cake 9 cm in diameter and 2 cm high.

Verongia longissima (Carter, 1882) de Laubenfels, 1936.—This is a long thin, ramose *Verongia.* Its color in life is reported to be gray, drab, or dull yellow (Carter 1882; de Laubenfels, 1936a, 1948), slowly turning carmine or grey upon death (de Laubenfels, 1936a, 1948).

The species was not found during the course of the present investigation and was reported from Station 20 only in the area by de Laubenfels (1953a, page 515).

Verongia sp.—OI 998, USNM 23552. This is also a long thin, ramose *Verongia,* which is persistently light brown on the upper surface and dull yellow on the lower one. On dying in air, or in alcohol, it quickly turns to dark purple and in alcohol remains thus indefinitely. It was found common at Stations 7, 10, and 11 and beachworn, macerated specimens were seen at Station 12.

Depth ranged from 2 to about 13 meters. Of significance, on every occasion when the author viewed this species underwater it was not attached, but merely lying on the bottom, generally on the sandy substrate of a grass flat or other somewhat protected area. The abundance of beachworn, macerated specimens seems to support the hypothesis of unattached habit.

Diameter of the individual branches of the sponge was about 1 cm while the length of some observed specimens exceeded 30 cm, the branches often intertwining to some extent.

Consistency in life is softly spongy.

The surface was minutely conulose, the conules being 0.5 to 1.5 mm high and 1 to 2.2 mm apart. The oscules were 3 to 6 mm in diameter and 0.9 to 2.8 cm apart; they were scattered over the surface of the sponge in an irregular fashion though a majority were located on the upper surface. A dermis about 15 μ thick covers the sponge.

The skeleton consisted of an irregular meshwork of spongin fibers averaging in size about 560 x 670 μ (range: 400 to 1050 μ). The concentrically laminated spongin fibers averaged 105 μ (range: 48 to 230 μ) in diameter, each with a central pith zone constituting 30 to 60 percent of its overall diameter.

The small ovate flagellate chambers averaged 20.2 μ in diameter (range: 14 to 33 μ).

A comparison of the data from these specimens with those from *V. fistularis, aurea, longissima,* and *fulva* (=*aurea* per de Laubenfels 1948) yields the impression that this sponge may indeed fall within the scope of *V. aurea* as recognized by de Laubenfels (1948: 85, 87), especially in view of the rapid color change noted above, but its living coloration, conule arrangement and spacing, dermal thickness, flagellate chamber

size, and oscular location resemble more closely those of *V. longissima* and therefore its final allocation is deferred to some future date.

Family DYSIDEIDAE Gray

Dysidea etheria de Laubenfels, 1936.—OI 1019, USNM 23557. This lamellate sponge is characterized by beautiful sky blue coloration, primary and secondary fibers that are both heavily cored with coarse debris, and a conulated surface. The bright blue color distinguishes it in the field.

Specimens were found at Station 8, November 17, 1956, and station 10 in the summer of 1957. The species appears to be fairly common, at least seasonally.

Dysidea crawshayi de Laubenfels, 1936.—OI 1047, USNM 23586. This is the third record of this sponge. It was redescribed briefly by de Laubenfels (1948: 145), and later redescribed by him in detail (1950a: 26-28).

One specimen was taken from the grass flat at Station 11, at 2.5 meters, by J. Branham, R. Hathaway and R. Bhatnagar on October 31, 1957. This specimen tended to be amorphous but had some low, broad lobes. Its color was not quite characteristic of the species but was a pinkish red, instead of the orange color previously recorded. Primary fibers were heavily cored with detritus and secondary fibers less so, which corresponds well with the original description.

Size was 6 cm in diameter and 3 cm in height. The mean sample size of the eurypyllous flagellate chambers was 69 μ (range: 53 to 84 μ).

Euryspongia rosea de Laubenfels, 1936.—OI 1044, USNM 23574. One specimen was taken on the grass flat at Station 11 on October 31, 1957, by J. Branham, R. Hathaway and R. Bhatnagar.

Shape was lobate to ramose, total height 18 cm, total diameter 9 cm. The diameter of each branch was about 2 cm. Color was light to medium brown. This differs from the recorded rosy red color and possibly may be accounted for by the several hours the specimens spent in air before reaching the laboratory.

Flagellate chambers ranged between 50 x 30 μ, and 80 x 50 μ.

Ianthella ardis de Laubenfels, 1950.—OI 1045, USNM 23576. This amorphous sponge was primarily a dark plum color externally and pink internally during life. It was taken at Station 7 on rock and sand, November 3, 1957. Upon its surface there appeared to be a yellow slime or sheen similar to that on *Iotrochota birotulata* (Higgin). Apparently it is not uncommon since it was found in two of the dredge hauls made in the area.

The consistency of my specimens was that of soft cork. The surface was covered with conules about 1 mm high and 2 to 5 mm apart and there was a definite, dense, dermis 30 to 45 μ thick covering the sponge. The endosome, in sections, appeared quite fleshy containing ovate, sacklike flagellate chambers in profusion. These were 22-31.9-49 μ in diameter. The laminated spongin fibers were 96-210.8-345 μ in diameter and appeared dendritic in arrangement, that is, they branched but seldom, if ever, anastomosed. This is attributed to the fact that the fibers were generally 1 to 2 mm apart in the sections and that their anastomoses were not seen because of the thinness of the sections. The fibers contained a large central pith area constituting about one-third of the diameter in smaller fibers to two-thirds of the diameter in larger ones. The small cells within the fibers, which set this genus apart (de Laubenfels 1948: 157), were also noted.

These specimens most closely match those that de Laubenfels (1936a: 31-32) originally reported as *I. basta* and which he later considered conspecific with *ardis* (1950a: 33). The morphology of my specimens and of de Laubenfels' *basta* specimen resembles closely that of the type specimen of *I. ardis* with the exception of color, flagellate chamber size, and dermal thickness.

Color in both my specimens and de Laubenfels' *basta* may be said to be purple while that in the *ardis* type specimen is reported yellow to emerald green (de Laubenfels 1950a: 31). Flagellate chamber size in de Laubenfels' *basta* specimen is 25 to 45 μ which matches the data from my specimens well, while the size in the *ardis* type specimen is about 30 to 60 μ. Dermal thickness in both my and the *basta* specimens is generally between 30 and 45 μ while in the *ardis* type specimen it is reported to be 15 μ (de Laubenfels 1950a: 32).

In spite of the differences noted above, I am reluctant to designate this as a new species at present because of the overall morphological similarity exhibited among

the specimens. Further specimens are needed to give an estimate of the range of variation in each population.

I am indebted to Drs. Willard D. Hartman and Patricia R. Bergquist for indicating the proper generic assignment of these specimens.

Family APLYSILLIDAE Vosmaer

Darwinella joyeuxi Topsent, 1889.—OI 1007, USNM 23550. The genus is peculiar for having triaxon horny spicules and is set apart for that reason.

During the course of the present investigation specimens of this species were taken at Stations 4, 8, and 13 between 2.5 and 14 meters on rock and sand bottoms. Shape was massive to amorphous. De Laubenfels (1953a: 517-518) previously reported a specimen from Station 20 as *D. mulleri.* As discussed below, this specimen is considered identical with those taken during this investigation.

This dull red, softly spongy, conulose sponge reached a maximum height of 10 cm and diameter of 15 cm. Its principal laminated spongin fibers averaged 50 μ (range 32 to 61 μ) in diameter and rarely were cored with siliceous spicular detritus and other material. The secondary, or connecting, fibers which had a mean diameter of 19.7μ (range 10 to 30 μ) were not so cored. The arrangement of these fibers appeared to be quite ordinary for the genus, as was the general architecture.

The horny, almost equi-rayed, triaxon spicules had rays averaging 10.4 x 559 μ (range 7 x 437 to 16 x 650 μ).

The ovate flagellate chambers had mean dimensions of 26.2 x 58.7 μ (range 14 x 39 to 39 x 61 μ).

Were it not for the slight amount of detrital coring of the principal fibers, these specimens would fall to *D. australiensis* Carter as recognized by Topsent (1905: CLXXVI, CLXXXIII) and Levi (1952: 38-39), or to *D. mulleri* Schultze if de Laubenfels' (1948: 168-170) broad concept of that species is considered valid.

Checking of de Laubenfels' (1953a) specimen slide from Station 20 failed to yield any evidence of detrital coring which, however, was rare even in my specimens. In all other respects, however, his specimen compared favorably to mine. De Laubenfels' statement (1948: 171) that some of the horny spicules in *D. joyeuxi* anastomose to form a reticulation independent of the principal keratose fibers was not verified by reference to the original description or to Topsent's later reference to this species (1905: CLXXXIV,CLXXXVII-CLXXXIX) and therefore is to be disregarded.

Probably the specimens of *Darwinella* heretofore reported by de Laubenfels (1950a: 38-39; 1953a: 517-518) are all *D. joyeuxi,* in view of the overall agreement between them and the specimens reported here and the relative rarity of coring material in these specimens. On the other hand, it may also be true that de Laubenfels' view is the correct one and that they represent *D. mulleri.* If this is true then *D. joyeuxi* also falls to *mulleri* on the basis of the evidence presented above. At this time I prefer to maintain the distinction between the two, at least until new specimens and data are forthcoming which may clarify the issue.

Family HALISARCIDAE Vosmaer

HALISARCA **PURPURA,** sp. nov.—(figs. 5-9). OI 1038, USNM 23589.

USNM 23589 is designated as the holotype; April 14, 1957 by Mr. J. Branham.

Locality and abundance.—This species was reported abundant and encrusting on the turtle-grass, *Thalassia testudinum* Konig, at Station 9 on the date of collection. Subsequent visits by the author failed to yield any new specimens. Depth was less than 1 meter.

Shape and size.—Basically encrusting, but the surface was somewhat lobate and therefore appeared almost wrinkled. The largest specimen was 6 cm long and 1-1.8 cm in diameter. A smaller specimen was 3.8 x 0.4 x 0.8 cm.

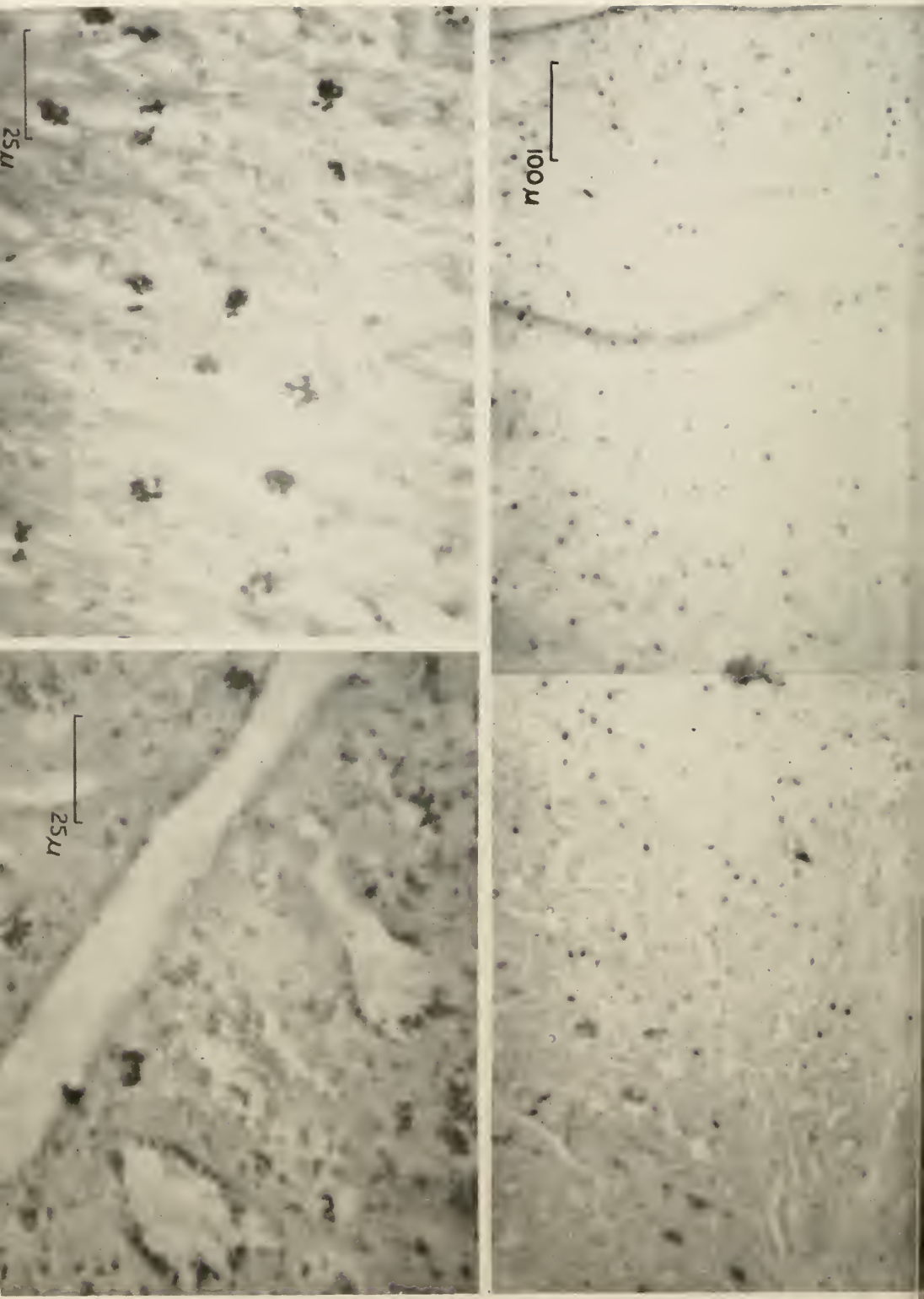
Color.—Color in life was a striking purplish-red, brighter than maroon. This color was found throughout the fresh organism by Mr. Branham but the color in alcohol was drab grey throughout.

Consistency.—Soft, almost colloidal.

Surface.—Smooth.

Oscules.—Not observed; they are presumed to be very small.

Ectosomal anatomy.—There was a protoplasmic dermis, over a 600 to 700 μ thick alveolar zone of small subdermal cavities which ranged in size from 2 x 2 μ to 20 x



Figures 5-7. Read with page turned sideways. **5** (top). *Halisarca purpura*, sp. nov., section. **6** (lower left). *Halisarca purpura*, sp. nov., section of outer alveolar zone. **7** (lower right). *Halisarca purpura*, sp. nov., section of choanosome.

37 μ. This alveolar zone contained many 8 to 32 cell developmental stages.

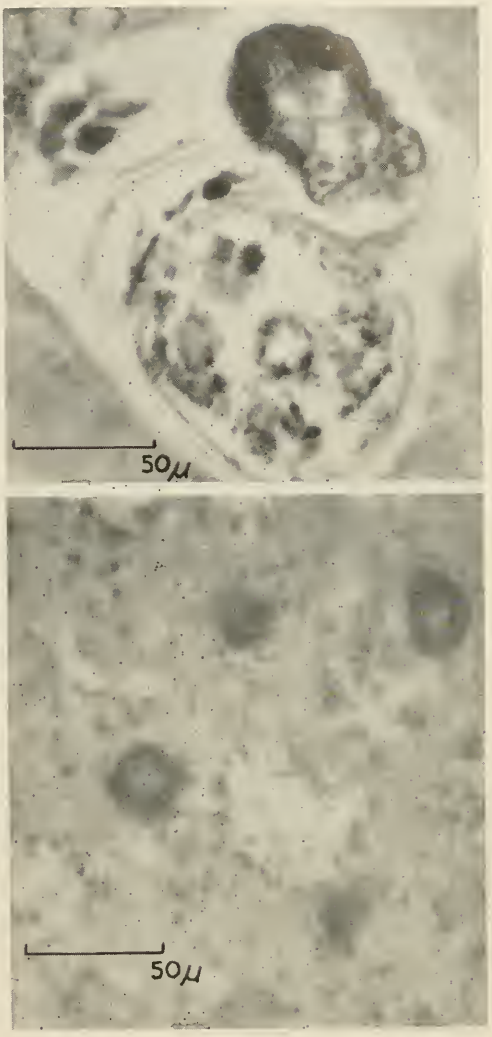
Endosomal anatomy.—This consisted of flagellate chambers, canals, and hyaline jelly between them. The flagellate chambers had a mean size of 21 x 38 μ (range in length: 18 to 80 μ; diameter 12 to 30 μ). They were long and sack-like and sometimes branched. There were a great many developing spermatocytes and oocytes in the endosome, indicating sexual maturity at the time of collection.

Skeleton.—None; only the colloidal ground substance was present.

Discussion: De Laubenfels (1948: 175) stated that the flagellate chambers of *Halisarca dujardini* Johnston are "commonly 25 microns in diameter by 60 microns to 150 microns long." The color is a dull yellowish brown. The diameter of the flagellate chambers of *H. magellanica* Topsent (1901b: 44) are reported to range between 70 and 100 μ. *H. magellanica* is purple in color.

Specimens taken at Station 9 by Mr. Branham have flagellate chambers which are in the range of *dujardini*, while their color resembles that of *magellanica*. Since there are few anatomical characters to go by in this genus, we might have an intermediate between the two species. Indeed, some authorities regard other members of the genus as conspecific with *dujardini*, but considering the wide range of the genus and the isolated occurrence of the forms reported, as well as the few distinct morphological characters, at the present I regard them as separate species as does de Laubenfels (1932, 1948).

A detailed study of the embryology in the manner of Levi (1956a) may further clarify the situation.



Figures 8-9. **8** (top). *Halisarca purpura*, sp. nov., section of spermatocysts. **9** (bottom). *Halisarca purpura*, sp. nov., section of oocytes.

Order Haplosclerina Topsent

Family Haliclonidae de Laubenfels, 1932

Haliclona rubens (Pallas, 1766) de Laubenfels, 1932.—OI 1037, USNM 23554. This dull red, ramose sponge was plentiful throughout the year along the beach at Station 12. Most specimens, however, were badly beachworn and macerated.

The oxeas which make up the skeleton in this species averaged 136 x 4.1 μ in size (range in length: 115 to 157 μ; width 1.8 to 7.3 μ). This agrees well with the range of Hartman's 1955 data from the Gulf of Campeche, and does not vary greatly from the de Laubenfels (1936a, 1949a) values from Florida and the Bahamas, though Carter (1882) and Wilson (1902) report larger spicules. Carter found 230 μ oxeas while Wilson's are reported to be 3 μ longer than the largest spicules in my specimens, or 160 x 4 μ. Hartman (1955) tabulated all of these data.

Haliclona rubens was reported in an annotated checklist for the study area (Menzel, 1956).

Haliclona viridis (Duchassaing and Michelotti, 1864) de Laubenfels, 1936.—OI 1014, USNM 23587. The coloration of this

sponge varied from light green to grey-brown. Its skeleton consisted entirely of oxeas, plus a few stylote and strongylote spicules that were clearly derived from the oxeas.

De Laubenfels (1953a) reported the species from Station 21 (USNM 23396). Measurements made on a slide of this specimen indicate that the oxeas had an average size of 165.9 x 5.7 μ (range in length: 144 to 201 μ; width: 2 to 10 μ).

Specimens on rock at Stations 4, 7, and 13, between 6.5 and 14 meters, were taken during the course of the present investigation. Spicule size was much nearer the "3 by 120 microns" size given by de Laubenfels (1950a) for Bermuda. The mean size found was 120.2 x 3.3 μ (length range: 96 to 153 μ; width range: 1 to 7 μ).

Haliclona permollis (Bowerbank, 1866) de Laubenfels, 1936.—OI 1036, USNM 23585. This is a brownish-grey or lavender *Haliclona*. Its shape varies from thickly encrusting to massive and amorphous. Its skeleton is reported to be comprised of an isodictyal reticulation of oxeas. Sometimes a few of the oxeas are modified to styles, but this is not uncommon in the genus.

This species is cosmopolitan and variable. De Laubenfels found spicule ranges of 3 x 90 to 5 x 100 μ from Plymouth (Note in de Laubenfels' Card Index of Porifera), 6 to 8 x 150 μ from California (1932: 121), 4 x 105 to 5 x 110 μ from Bermuda (1950a: 47). The skeleton of the present specimen, taken from Panama City, had oxeas averaging 5 x 150 μ (range: 1 x 109 μ to 7 x 178 μ).

Because of the pronounced isodictyal reticulation of the skeleton, and the lack of any dermal or cortical specialization, this specimen is placed here. However, the length of the spicules may indicate that it is a separate species.

Haliclona sp. (?).—USNM 23686, 23687 (figs. 10, 12). On both November 4 and November 16, 1956, specimens were taken at Station 9 by Mr. R. Hathaway and the author.

One specimen consisted of a number of ramose arms, 0.5 to 1 cm in diameter, extending from a base of 1 x 2 cm. The maximum overall length was about 6 cm. Another specimen appeared to be one of the ramose arms plus a few pieces of such an arm. The piece was 0.5 to 1 x 6.5 cm. One specimen in alcohol was light greenish tan and the other was white. Consistency was softly compressible and both specimens were easily torn.

The surface of both specimens was typically haliclonid and the endosome of both was isodictyally recticulate in places. There were also vague tracts containing 3 to 6 spicule rows. The principal spicule was a sharp-pointed oxea 96-124-139 x 1.8-6.1-10.6 μ in the tan specimen and 103-131-167 x 2-6.7-11 μ in the white one. There seems to be a tendency for the larger spicules to become strongylote or stylote; for example, in the tan specimen the strongylote type was 77-104.2-123 x 7-8.8-13 μ and the stylotes were 105-118.6-125 x 7-8.6-11 μ. Only the thicker spicules were so modified; there seemed to be no juvenile forms of these types. In addition the overall length seemed to diminish as this rounding-up occurred, as indicated by the fact that the mature oxeas seemed to be longer than the styles of comparable width, and the styles in turn were longer than the strongyles. There was no localization of these types within the specimen. This, with the reticulate nature of the sponge and the ramose branches from the main body, seem to indicate the genus *Pellina* Schmidt but the lack of any dermal specialization indicates *Haliclona*.

Haliclona erina de Laubenfels (1936b: 457) seems extremely close to the present specimens, and it may be that they are conspecific with it. De Laubenfels listed the oxeas as being 3 x 120 to 10 x 200 μ but made no mention of a pronounced strongylote and stylote modification. Indeed, his slide shows relatively few such forms. For this reason, I feel that the present conservative course is wisest.

Family Desmacidonidae Gray

Xytopsene sigmatum de Laubenfels, 1949. —OI 1017, USNM 23548. This bright orange, amorphous sponge with conical elevations was found at Station 1, on Tampa limestone between 1 and 3 meters deep, throughout the year. It reached a height of 6 cm and a base diameter of up to 10 cm.

The spiculation is distinctive, containing tylotes, two sizes of sigmas, and also two sizes of isochelas that are primarily arcuate

Figures 10-11. **10** (top). *Haliclona* sp. (USNM 23686, 23687). **11** (bottom). *Callyspongia repens*, sp. nov. (USNM 23551).

but verge towards palmate. In his original description de Laubenfels listed only one type of isochela, but Dr. Willard Hartman found two in slides of specimens from Station 1. De Laubenfels' slide also shows two sizes of isochelas.

The sizes of the various spicule types are as follows: in the ectosome, tylotes 262-280.3-314 x 3.0-4.36-5.5 μ, chelas 33-39.8-44 and 11-14.5-15 μ in chord length, sigmas 40-45.2-51 and 11-13.6-15 μ in chord length, in the endosome, tylotes 249-270.5-301 x 2.9-4.24-5.7 μ, chelas 22-38.9-44 and 13-15.2-18 μ, and sigmas 40-43.9-53 and 11-14.3-15 μ.

This is the second record of the sponge. This specimen was identified by the late Dr. de Laubenfels, who originally described the species from the Western Bahamas.

Family CALLYSPONGIIDAE de Laubenfels

Callyspongia vaginalis (Lamarck, 1814) de Laubenfels, 1936.—OI 996, USNM 23565. This, the common tube sponge, was found previously in the area at Station 20.

Living specimens of the sponge were taken at Station 4, depth 11 meters, from a rock substrate. Beachworn specimens were found throughout the year at Station 12.

The color in life was buff brown. Hollow cylindrical tubes 3 cm in diameter and 20 cm in height were found. Spiculation was entirely of oxeas, and the structure was typically callyspongiid, *i.e.*, the dermal specialization consisted of a secondary reticulation of small fibers with the coarser primary meshwork, thereby giving an overall appearance of distinctly smaller mesh size at the surface.

The spicules of area individuals averaged 92 x 3 μ (range: 84 x 2 to 101 x 4 μ), which is fully 20 μ longer than the largest thus far recorded for the species. In view of the overall agreement with the published description (de Laubenfels, 1936a: 56) I do not feel that this difference constitutes sufficient evidence for designation as a new species, and therefore it is placed here.

The surface of many of the tubes was covered with small bright sky-blue spots 1 to 2 mm in diameter and 3 to 4 mm apart. These apparently represent a species of *Parazoanthus,* presumably *P. parasiticus* (Duchassaing and Michelotti) Verrill as described by Duerden (1903: 495). My specimens however were blue whereas Duerden's were brown, *i.e.*, clear with pale brown tentacles. Thus possibly these represent a new species. Evidently these organisms are common on *Callyspongia* for most specimens observed were seen to have them, either actually present or represented by pits in beachworn macerated specimens.

CALLYSPONGIA **REPENS**, sp. nov.—OI 1008, USNM 23551 (figs. 11, 13).

The holotype is designated as USNM 23551.

Locality and abundance.—One specimen was taken during September, 1955, by Dr. John Morrill in the vicinity of Station 10. It was also taken in abundance on September 26, 1956, as beachworn specimens, at Station 12 shortly after a storm. The substrate was rock.

Shape.—Repent ramose; it has branches 1 to 2 cm in diameter which intermingle and coalesce as they cross each other making the sponge seem almost flabellate. It may be hollow but is not the conspicuous tube that *C. vaginalis* is; rather its branches may or may not be hollow depending upon circumstances and thickness, the thicker branches more commonly being hollow.

Size.—The largest specimens reached a total length of 18 cm and a diameter of 9 cm.

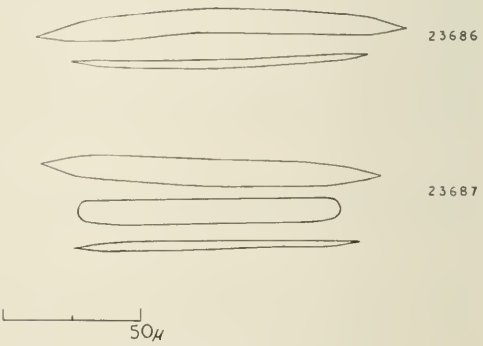


Figure 12. Spicules of *Haliclona* sp.

Color—Yellow-green to cream-colored in life, pale yellowish tan.

Oscules.—Widely scattered, generally terminal or on the upper side; diameter about 6 mm.

Consistency.—Somewhat spongy and elastic but fragile.

Ectosomal anatomy—Typically callyspongiid; there is a primary meshwork of fibers averaging about 390 x 520 μ (range: 250 to 775 μ), which encloses a finer secondary meshwork of smaller fibers about 94 x 135 μ (range: 57 to 210 μ). Both sets of fibers generally are heavily cored with spicules; the primary fibers contain 1 to 11 spicule rows and range in diameter from 19 to 58 μ, while the secondaries contain only 1 to 4 spicule rows and are between 10 and 29 μ across.

Endosomal anatomy.—Fibro-reticulate, the endosomal portions of the primary surface fibers form a meshwork averaging about 280 x 400 μ and range in diameter from 110 to 640 μ. Very little sponge tissue was seen, for the most part it seems confined to the areas adjacent to the fibers.

Skeleton.—The spiculation resembles that of *C. procumbens* (Carter) as described by de Laubenfels (1936a: 57) under the name *Patuloscula plicifera* (Lamarck) and later corrected by him (1950a: 61; 1953a: 523). There are oxeas, some verging to strongyles, 75-100.3-107 x 1-3.9-7 μ, as well as mi-

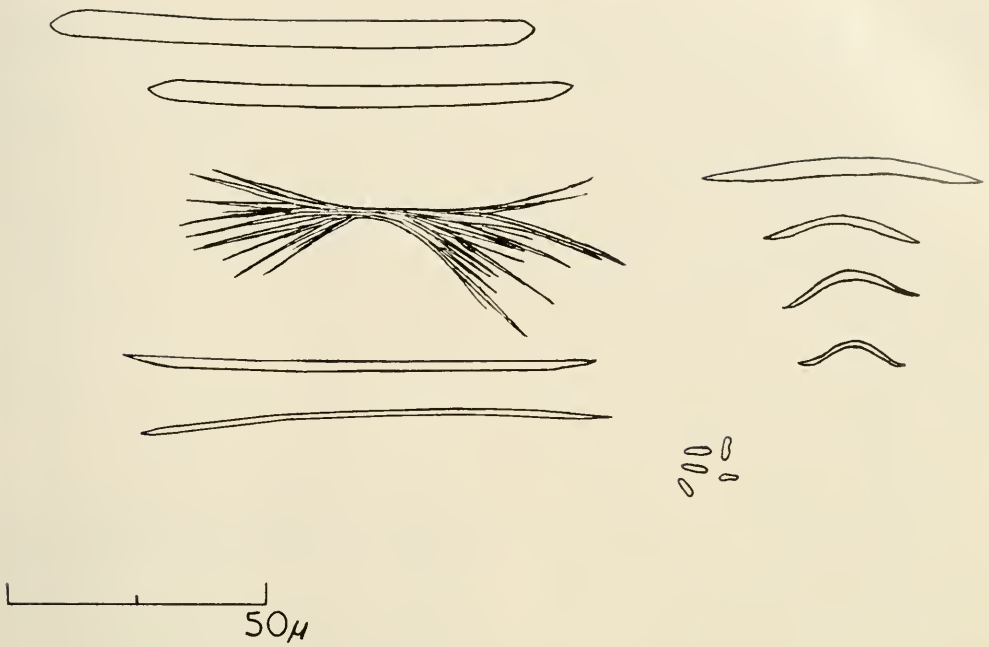


Figure 13. Spicules of *Callyspongia repens*, sp. nov.

croxeas of which many are bent to resemble toxas so closely as to be mistaken for them. Three classes of microxea were found. There were raphides, 18-33.8-55 μ, and two sizes of bent microxeas many of which went so far as to become pseudo-toxas. The larger ones were 23-25.1-32 x 1.8-2.2-2.7 μ while the smaller were 7-14.4-20 μ long. There were also small siliceous objects 3-4.1-6 x 0.8-1.2-1.6 μ which looked like little bright kidney beans in the field.

Discussion.—This species most resembles *C. procumbens* (Carter 1882: 365) from which it differs chiefly in color, somewhat smaller mesh size than that reported by de Laubenfels (1936a: 57-8), and in the densely packed fibers as opposed to the sparsely cored fibers of *procumbens* originally reported and verified in de Laubenfels' preparations. Indeed, de Laubenfels' material matches the literature data (Carter 1882: 365; Dendy 1890: 355-56) with the one exception that de Laubenfels' slides contain thinner spicules than the material reported on by previous workers. Burton's (1934: 539) report of toxas in the type specimen of *procumbens* is also matched by de Laubenfels' data.

Though the spicule size of this species better approximates the data presented by Carter and Dendy than does that of de Laubenfels, the other morphological differences cited above preclude the designation of my specimens as *procumbens* both on a quantitative basis and on the purely qualitative impression resulting from the comparative material examined.

Order Poecilosclerina Topsent
Family ADOCIIDAE de Laubenfels

Adocia neens (Topsent, 1918) de Laubenfels, 1936.—OI 1031, USNM 23601. This species was found as an encrustation 3 to 4 mm thick and 3 to 4 cm in diameter on *Geodia gibberosa* Lamarck at Station 11, depth 2.5 meters, on October 31, 1957. Color was white in life and is the same in alcohol.

The presence of a neatly reticulate skeleton of oxeas verging toward strongyles, and a detachable reticulate dermal skeleton, place the specimens in this species. There seem to be two sizes of spicules. One averaged 126 x 6 μ (range: 110 to 134 μ), the other averaged 110 x 3 μ (range: 98 to 116 μ). The small ones are undoubtedly immature. De Laubenfels (1936a: 58) indicated that the spicules of his specimen were 118 x 5 μ in general and some were

as small as 105 x 1 μ. Thus the Apalachee Bay specimen has slightly longer spicules, a difference which I feel not marked enough to justify designation of a new species.

Family COELOSPHAERIDAE Hentschel

COELOSPHAERA **FISTULA**, sp. nov. —OI 1049, USNM 23583 (figs. 14, 16). The holotype is designated as USNM 23583.

The specimens were taken from the Station 4 area April 29, 1957, by J. Branham and R. Hathaway.

Locality and abundance.—This species was relatively common in the vicinity of Station 4 throughout the year. It was growing on tests of dead sand dollars, *Mellita quinquiesperforata* (Leske), at a depth of 12 to 14 meters.

Shape.—Fistulate, like a small bent finger standing erect upon the surface of the sand dollar test. No basal mass was observed.

Size.—Up to 1 cm in height and between 5 and 7 mm in diameter. This represents the largest found though many were considerably smaller.

Color.—White, both in life and in alcohol.

Oscules.—No obvious vents were found, as is often the case in the Coelosphaeridae.

Ectosomal anatomy.—This consisted of a dermal region, 75 to 100 μ thick, densely packed with spicules in confusion; their interstices were also packed with organic material, flesh, and perhaps spongin.

Endosomal anatomy.—The endosome was wanting and was replaced by a hollow fluid-filled area. Presumably the fluid was sea water but no investigations were made concerning it.

Skeleton.—The spicules were packed in the ectosome in confusion and did not invade the hollow central cavity. The megascleres were tylotes 107-211-240 x 4-4-5 μ. The mean size of the heads at each end was 5.7 μ (range: 5 to 7 μ). The microscleres were unguiferate isochelas 9-10.5-12 μ, and sigmas 25-40.8-53 μ. The chelas generally bore four teeth at each end. A few were seen that seemed to have three teeth but observation was difficult due to their position on the slide. Under lower magnifications these may appear to be arcuate isochelas.

Discussion.—The sponge is placed in this genus due to its structure and spiculation. The size and range of its spicules effectively exclude it from any of the existing described species. In *C. actinioides* (Hallmann, 1914) from Australia, the microscleres are closest in size to those of the Station 4 specimens, but the chelas are arcuate and the megascleres are over 100 μ longer. *C. tunicata* (Schmidt, 1870), the only West Indian member of the genus to date, does have broad spatulate three-toothed isochelas. However, they are too large, averaging about 31 μ (Topsent, 1920: 17) and do not resemble closely those of the present specimens.

Rhizochalina oleracea Schmidt, 1870.—USNM 23688 (figs. 15, 17). Specimens were found growing on *Geodia gibberosa* at Station 11, October 31, 1957. It was de-

Figures 14-15. **14** (top) *Coelosphaera fistula*, sp. nov. (USNM 23583) on *Mellita* test. **15** (bottom) *Rhizochalina oleracea* Schmidt (USNM 23688).

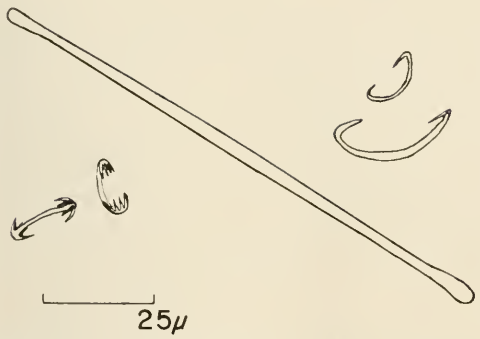


Figure 16. Spicules of *Coelosphaera fistula*, sp. nov.

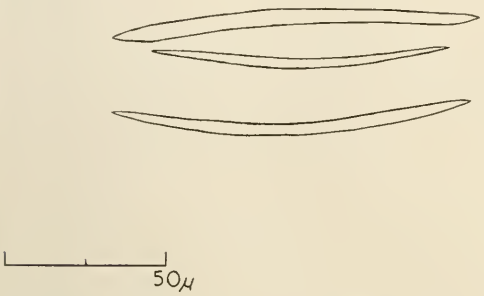


Figure 17. Spicules of *Rhizochalina oleracea* Schmidt.

scribed as *Phloeodictyon nodosum* by George and Wilson (1919: 152-53) from Beaufort, N. C. This was corrected by de Laubenfels (1947: 35) on the basis of his study of "many West Indian specimens of *oleracea*," though the results of these studies were never published. A search of de Laubenfels' slide collection yielded five specimen slide sets from the West Indian region definitely identified as *oleracea* by him. The spicular and gross morphological data from these is compared to both the literature data and my own in Table 1. Wells, *et al.* (1960: 212) also confirm de Laubenfels' opinion after examining George and Wilson's type specimen.

My specimen consisted of fingerlike cylindrical fistulae arising from an encrusting basal portion 2 to 5 mm thick. The fistulae were 2 to 4 mm in diameter and 2 to 4 cm long. They were hollow and the ends of each were closed and were not oscular sites. Color was white.

The surface of the fistular wall was smooth, being a tangentially arranged, unispicular, triangular reticulation supported by a more or less perpendicular unispicular reticulation above vague tracts or confusedly arranged spicules lying parallel to the surface. The perpendicular reticulation is somewhat vague in itself and holds the surface layer one spicule length above the interior layer. The endosome is wanting in the fistulae, being replaced by the large central cavity.

The ectosome of the basal portion is similar to that of the fistulae except that the tangential dermal reticulation appears more polygonal due to a somewhat more dense arrangement of the spicules which comprise it. Also, here we find that the tracts just below the perpendicular reticulation are more definite. They are more closely packed with spicules and range from 60 to 135 μ in diameter. These, in turn, are supported above extensive subectosomal cavities 90 to 380 μ in diameter by perpendicular extensions of some of the endosomal tracts.

Below the subectosomal cavities lies a loose mass of vague and distinct tracts of spicules 45 to 125 μ in diameter forming a vague reticulation. There are also many spicules loosely scattered in vague bundles or in confusion throughout the flesh.

The general morphology of this sponge is in close agreement with that of George and Wilson's, Topsent's (1920: 2), and de Laubenfels' specimens (Table 1). The size range of the oxeas which comprise the skeleton matches well the data of Wilson (1902: 395), George and Wilson, Topsent, and de Laubenfels' smaller spiculed specimens though his larger spiculed specimens, *i.e.* USNM 22390, 22388, and BNMH TW 17 VIII, may require reallocation on further study (see Table 1). The color difference from brown (Topsent) to brownish white (George and Wilson) is considered insignificant, especially since de Laubenfels' specimens are recorded as ranging between yellowish drab and pale grey in life.

That this sponge has not been found here before is probably due to its small size and inconspicuous habitus. Probably it is far more common than this one collection indicates.

Family Plocamiidae Topsent

HOLOPLOCAMIA **DELAUBENFELSI**, sp. nov.—OI 1039, USNM 23596 (fig. 18).

The holotype is designated as USNM 23596.

TABLE 1.
Comparative Data on Rhizochalina oleracea

Collection	Museum Number	Identified by	Basic Shape (+ fistulae)	Original Data μ	Supplementary Data μ
Apalachee Bay	USNM 23688	Little	Encrusting	Base, Ecto. 93-104.6-110 x 3-4.2-4.3 Base, Endo. 81- 98.2-109 x 1-3.8-6 Fistula 93-110.9-132 x 1-3.9-6	
				By de Laubenfels	By Little
Johnson Coll. Puerto Rico	USNM 22271	de Laubenfels	Semispherical (fistulae branch)		105-118.8-134 x 2-3.4-5
Puerto Rico	USNM 22389	de Laubenfels	Semispherical (+ "Roots")		105-122.5-157 x 3-3.9-5
Puerto Rico	USNM 22390	de Laubenfels	Spherical (+ "Roots")	160 x 4, 200 x 7, 210 x 10	211-236.1-259 x 7-7.6-10
Puerto Rico	USNM 22388	de Laubenfels	Spherical (+ "Roots")	160 x 9	195-205.6-211 x 6-8.4-10
Brit. Mus. Nat. Hist. (West Ind.)	BMNH TW 17 VIII	de Laubenfels	Hollow Mass	250 x 10	211-253.5-278 x 4-7.8-10
				By George & Wilson	By Wells *et al.*
Beaufort, N. C. (George & Wilson)	USNM 23611	de Laubenfels, Wells *et al.*	Encrusting	100 x 4-5	94-120 x 3-6
				By Wilson	
?	?	Wilson	Subspherical	140 x 5	
				By Topsent	
Strasbourg	?	Schmidt	One piece + fistula	85-143 x 2-3	

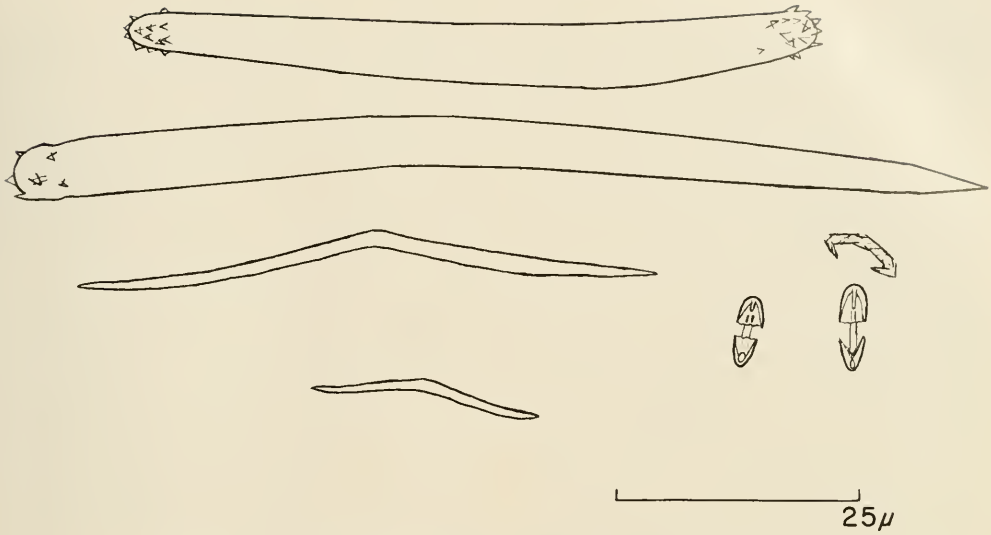


Figure 18. Spicules of *Holoplocamia delaubenfelsi*, sp. nov.

Locality and abundance.—One specimen was found growing on an oyster shell attached to a specimen of *Verongia* sp. at Station 10, August 13, 1957 by Dr. John Morrill and the author. Depth was 2.5 meters.

Shape.—Encrusting; the specimen was encrusted completely around the oyster shell making the sponge appear superficially massive and amorphous.

Size.—Diameter of the encrusted shell was about 3 cm and it was completely covered. Height of the sponge was approximately 1 to 3 mm.

Color.—Bright orange-red in life, and dark drab in alcohol.

Oscules.—No definite vents were seen.

Consistency—Firm, yet slightly elastic.

Ectosomal anatomy.—No definite dermis was observed. The surface was somewhat hispid since the tufts of plumose columns of spicules project through the surface.

Endosomal anatomy.—The endosome was made up of two regions, a confused mass of spicules which formed a base, and plumose columns of spicules which extended to the surface. These principal tracts contained 3 or 4 spicule rows and were 20 to 30 μ in diameter. They seemed almost axinellid in that they were so plumose. These were joined by secondary tracts 1 or 2 spicules wide, 8 to 10 μ in diameter, and one spicule long, thus appearing like rungs of a ladder between two upright plumose columns. The resulting mesh varied in size up to 150 x 190 μ, which seemed to be the modal size. Also observed were a few pieces of concentrically laminated spongin fiber 85 to 170 μ in diameter, containing pith. These appear to be dendritic because some branching was observed but no recrossing. These fibers were 290 to 960 μ apart in the sections.

Skeleton.—The megascleres consisted of strongyles and styles, both of which may be slightly acanthose at or near their rounded ends. The strongyles, mean size 138 x 9 μ (range: 112 to 153 μ), made up the bulk of the basal mass while the styles, mean size 265 x 15 μ (range: 199 to 306 μ), made up the bulk of the plumose columns, though both were found throughout the sponge. The strongyles characteristically had unequal ends, the smaller end corresponding to the pointed end in styles. They appeared like styles that had rounded up short of their goal. The microscleres included toxas, mean size 79 μ (range: 48 to 103 μ), and predominantly palmate isochelas, mean chord length 14 μ (range: 11 to 16 μ). The shovels on the isochelas averaged about 4 μ across. A few arcuate chelas within this size range were also found.

Discussion.—Lévi (1952: 54) advocated dropping *Holoplocamia* in synonymy to *Plocamilla* Topsent (1928: 63), but Topsent stressed that *Plocamilla* was set up for

sponges in which there was no differentiation of primary from secondary tracts such as are cited by him (1928: 63) for *Plocamia* and therefore also for *Holoplocamia* since this is separated from *Plocamia* only by the presence of spiny rather than smooth principal (diactinal) spicules (de Laubenfels 1936a: 75; plus personal communication). Therefore, I feel that the genus should be retained distinct from *Plocamilla.*

All other species within this genus have diacts entirely spined except the one described by Sollas (1879: 44) as *Plocamia plena* from West Africa. Its diacts are described as only slightly spined at the ends like those of the present specimen. The present specimen differs from *H. penneyi* de Laubenfels (1936a: 76), a Tortugas sponge, in size and relative thickness of spicules, in color, which in *H. penneyi* is brownish orange, and in the fact that the chelas of *H. penneyi* have rotated shafts so that one shovel is at right angles to the one at the other end.

The species is named in honor of the late world sponge authority, Dr. M. W. de Laubenfels, whose interest and confidence in me have been major factors in sustaining my work.

Family Cyamonidae de Laubenfels

Cyamon vickersi (Bowerbank, 1863) Gray, 1867.—OI 1046, USNM 23563. One specimen was taken at Station 4, November 3, 1957. Depth was 11 meters. The specimen was an encrustation less than 1 mm thick on a piece of limestone. The color was orange.

The species may be common; its hard texture and thinly encrusting habitus led to overlooking many such pieces of orange-encrusted limestone in the course of dredging. This specimen was brought back to the laboratory only as a check.

The principal spicules were tetraxons, and a few pentactines (which are aberrant tetraxons) with the rays approximately equal, rounded and acanthose near the end of each ray. The rays in this specimen averaged about 41 μ (range: 20 to 55 μ). There were also a few subtylostyles about 877 x 13 μ, as well as very long, thin styles which echinated the surface, being perpendicular to it with their points out. They were 2 to 6 μ wide and up to 2 mm long, but most were broken. No acanthostyles, which supposedly give rise to the tetraxons (Dendy 1921: 117), were found. A few tetraxons had one acanthotylote-tipped arm very long in relation to the other arms, which seemed to be stubby in these cases. Thus, the part corresponding to the point in Dendy's developing tetraxons is acanthotylote, possibly indicating an intermediate stage in development.

The species was redescribed in detail by de Laubenfels (1936a, 1950a).

Family Myxillidae Hentschel

Merriamium tortugasensis de Laubenfels, 1936.—OI 1009, USNM 23561 (figs. 19, 21). Several specimens of this sponge were taken at Station 7, depth 10 meters, November 3, 1957. One other small specimen was taken at Station 4, depth 12.5 meters, the same day, thus indicating that the sponge is common, at least seasonally, within the area. The substrate was rock.

Color, alive, was fire red. Shape was massive. The largest specimen measured 5 x 3 cm wide and 6 cm high.

The spiculation of tornotes, acanthostyles, and arcuate isochelas is distinctive.

Family Tedaniidae Ridley and Dendy

Tedania ignis (Duchassaing and Michelotti, 1864) de Laubenfels, 1936.—OI 1061, USNM 23560. Several specimens of this sponge were taken at Station 10, August 13, 1957, and also at Station 11, October 31, 1957. Depth in both cases was about 2.5 meters; substrate in the first case was *Sargassum* and in the second was *Geodia gibberosa.* Habitus was encrusting to massive. This sponge is thought to be extremely abundant, at least seasonally.

The orange to pinkish-red coloration plus the spiculation of tylotes, styles (rarely subtylostylote), and roughened raphides are distinctive. A further distinctive feature of the species is that the heads of the tylotes are faintly microspined near the apex. It was redescribed in detail by de Laubenfels (1936a, 1950a, 1950b).

Lissodendoryx isodictyalis (Carter, 1882) Topsent, 1889.—OI 1011, USNM 23584. One specimen of this species was found at Station 10, August 13, 1957 permeating between the trellis of ascon tubes of *Leucosolenia canariensis* (Miklucho-Maclay); depth 2.5 meters. It was subsequently found in the Panama City area encrusting on steel buoys at a depth of less than 1 meter.

The lavender to brownish-green color of the exterior and the yellow interior are distinctive, as is the spiculation which consists of tylotes, slightly bent styles, sigmas, and arcuate isochelas. Hartman (1958: 41) discussed in detail whether we should separate the *carolinensis* type (Wilson, 1911) and the *isodictyalis* type (Carter, 1882). They were placed together by de Laubenfels (1947: 35). There are distinct differences in the microsclere populations of the two groups. The *carolinensis* type has large sigmas and small chelas while the *isodictyalis* type has small sigmas and large chelas. Hartman concluded that since both of these variations occur side by side in the Mediterranean they should not be separated at present.

The specimens collected from this area were of the *carolinensis* type having larger sigmas than chelas. The dimensions of the spicules are: tylotes, mean 166 x 4 μ (range: 146 to 176 μ); styles, mean 168 x 6 μ (range: 157 to 183 μ); sigmas, mean chord length 37.9 μ (range: 21 to 63 μ); arcuate isochelas, mean chord length 24.9 μ (range: 16 to 28 μ).

The species was redescribed by de Laubenfels (1936a, 1950a, 1953b). He noted (1953b: 21) the permeating habitus mentioned above.

Family MICROCIONIDAE Hentschel

Microciona prolifera (Ellis and Solander, 1786) Verrill, 1873.—OI 1002, USNM 23562. This orange-red to dull brick-red, encrusting to lamellate, lumpy sponge was abundant and was collected throughout the year at Stations 1, 2, and 9. Depth was between 0 and 2 meters. Its size ranged from a thin encrustation to a lumpy structure up to 6 cm wide and 9 cm high. Shape is largely governed by environment. On *Sargassum* and *Thalassia* it was usually encrusting. On limestone in areas of current, it was generally lamellate, and on sand substrate it appeared as a sub-spherical mass of short lumpy branches. In this last area it was in a tidal pool and hence little disturbed by currents.

The skeleton consisted of plumose columns of subtylostyles with small heads, echinated by acanthostyles. The microscleres were toxas and palmate isochelas, with an occasional arcuate isochela. There were two categories of subtylostyles, 165-440-529 x 11-19-21 μ and 133-266-402 x 2-4-7 μ. The larger ones were often almost stylote in that the head was so lightly developed. Two categories of acanthostyles also were found, one entirely acanthose 71-87-103 x 5-7-7 μ, and the other with only the head acanthose 116-174-223 x 9-11-12 μ. The palmate isochelas had a mean chord length of 17.1 μ (range: 14 to 20 μ), while the toxas averaged 33.5 μ (range: 16 to 45 μ).

This species was redescribed by George and Wilson (1919: 157) from Beaufort, N. C. They also described a new species, *Esperiopsis obliqua,* in the same paper (page 148): this was said by de Laubenfels (1947: 35) to be conspecific with *M. prolifera.* Wells *et al.* (1960: 218) on the other hand cited evidence that *E. obliqua* is a valid species and restored it to specific rank as *Tenaciella obliqua* since its spicules are enclosed in the spongin fibers rather than echinating them as in *Esperiopsis.* Hartman (1958: 36) wrote an excellent discussion of *M. prolifera* in which the data of previous authors were brought together in tabular form.

EURYPON **CLAVATELLA,** sp. nov. —OI 1030, USNM 23578 (fig. 22).

The holotype is designated as USNM 23578.

Locality and abundance.—One specimen was taken at Station 4, depth 10 meters, on rock and sand bottom.

Shape.—A thin encrustation on limestone.

Size.—Less than 1 mm thick, in patches up to 1 cm square. It was nearly invisible and subsequent investigation undoubtedly will yield more specimens.

Color.—No positive data are available at present. The limestone originally was covered with a vivid purple (lavender-red) substance, even in areas where there was no sponge. This color faded to white and was attributed to a coral. The sponge is drab in alcohol.

Consistency.—Softly fragile.

Surface.—Hispid, which is characteristic of the genus.

Oscules.—None observed.

Ectosomal anatomy.—No specialization.

Endosomal anatomy.—Microcavernous and fleshy. There seems to have been a basal plate of spongin from which vague plumose tracts of spicules rose vertically to the surface, a distance of about 500 μ on the average.

Skeleton.—The vague plumose columns

of spicules were made up primarily of tylostyles and were echinated by smaller acanthostyles. Many tylostyles and styles stand erect on the base between the columns, as do the acanthostyles. The tylostyles measured 249-384-470 x 14-15-21 μ with an average head diameter of 20 μ. The styles averaged 361 x 4 μ (range: 351 to 392 μ). The acanthostyles measured 75-102-145 x 5-6-9 μ, and their head ends averaged 8.4 μ in diameter. The styles possibly represented acanthostyles which lost their spines as they increased in size. In addition, what appeared to be vermiform stylote and tylote spicules were seen in the spicule slide. Some were highly contort. They ranged in mean chord length from 18 x 0.5 to 35 x 2 μ. None was found in the sections, however, and I concluded that they were not proper spicules.

Discussion.—This species resembles most closely *E. clavata* (Bowerbank) Gray, which was redescribed by de Laubenfels (1950a: 79) from Bermuda. However, the great difference in spicule size leads to the conclusion that this is a distinct species. The tylostyles in this specimen only approach one quarter the size of those of *clavata* and the range in size of the acanthostyles, while overlapping to a considerable extent, is much larger in *clavata*. A further difference is the presence of the styles.

If the presence of vermiform spicules is confirmed subsequently and actually they are proper spicules in this species, then it would fall to *Bubaris*. Their absence in pieces containing the basal plate suggests that they were not proper to the specimen.

Thalyseurypon vasiformis de Laubenfels, 1953.—This drab to black, vase-shaped sponge was taken at Station 21 on October 27, 1948. Originally it was described by de Laubenfels (1953a: 525). It was not found during the course of the present investigation.

Family Ophlitaspongiidae de Laubenfels

Carmia macilenta (Bowerbank, 1866) Gray, 1867.—OI 1018, USNM 23559 (fig. 23). This species is new to the Gulf and Caribbean region and therefore a detailed description is warranted. The genus was incorporated into the genus *Mycale* by Topsent (1928: 84); Burton (1956: 129) reported the species from the central eastern coast of Africa.

The genus *Carmia* is considered here to be valid, after the classification of de Laubenfels (1936a: 118).

Locality and abundance.—This sponge was common at both Stations 10 and 11, depth 2.5 meters. It was found on *Sargassum, Thalassia*, and *Ulva*. On October 31, 1957, it was found at Station 11, and on August 13, 1957, it was taken at Station 10. It was taken also in the vicinity of Station 10 in September, 1955, by Dr. John Morrill.

Shape and size.—Generally it was thinly encrusting on the available vegetation, but in Dr. Morrill's specimen it was thickly encrusting (on *Sargassum*). The largest mass was about 2 cm long and 0.5 cm in diameter with the *Sargassum* stem in the middle. In some places thickness exceeded this, and there were, of course, many smaller areas of thin encrustation.

Color.—Orange-red to orange in life; it faded quickly to grey-white in alcohol.

Surface.—Superficially hispid in effect, probably due to numerous tracts of spicules which terminated in surface brushes.

Oscules.—One oscule on the 1955 specimen measured 4 mm in diameter. It was partly closed by a thin sphincter membrane to an aperture 2 mm in diameter. Small oscular openings about 2 mm in diameter were about 3 mm apart in other specimens.

Ectosomal anatomy.—A protoplasmic dermis, supported in large part by tangential tracts of spicules directly beneath it, is present as well as the perpendicular tracts which pierce it.

Endosomal anatomy.—The endosome comprised a region of many dense spicule tracts forming a confused mesh or trellis-work with the mesh size ranging from 70 x 100 to 300 x 500 μ. What little flesh there was, was scattered about the edges of these meshes along the tracts. Here the microscleres were found in profusion. The primary spicule tracts contained 12-20 spicule rows and ranged from 30 to 70 μ in diameter. Secondary spicule tracts containing 5-8 spicule rows, 15 to 25 μ in diameter, also meandered about. The haphazard crossings of these two types of spicule tracts formed the mesh.

Skeleton.—Megascleres consisted of subtylostyles with small heads, plus styles. The subtylostyles averaged 211 x 3 μ with a range from 173 to 256 μ. A few immature

ones measured about 171 x 2 μ. The styles had a mean length of 218 μ (range: 173 to 255 μ). Microscleres included palmate anisochelas in three categories, plus sigmas and toxas. The chord length sizes of the chelas were 13-16.3-18, 22-24.2-31, 40-43.6-46 μ. The sigmas were 35-84.9-96 μ, while the toxas were 53-111-221 μ in length.

Discussion.—Possibly this sponge might constitute a new species in view of some minor differences between it and Bowerbank's description, but I concur with the opinion of the late Dr. M. W. de Laubenfels (personal communication) that these are not enough to separate it from *macilenta* at present.

Family Amphilectidae de Laubenfels

Toxemna tubulata (Dendy, 1905) Hallmann, 1917.—OI 1027, USNM 23595. Several small specimens of this yellow sponge were taken from the surface of *Geodia gibberosa* at Station 11 on October 31, 1957, at 2.5 meters depth.

This sponge was redescribed in detail by de Laubenfels (1936a: 124), but the generic name was incorrectly written as *Toxemma.* He described the shape as massive to amorphous in contrast to Dendy's original description (1905: 105) which stressed cylindrical shape.

The specimens from this area were slender (1 to 2 mm diameter) cylindrical digitate processes rising from the substrate a distance of about 1 cm, thus bearing out the original description. The spicules were styles 244-259.6-297 x 4-4.5-5 μ, and abundant microscleres containing raphides 29-103-230 x 1-1.5-2 μ, sigmas whose chord length measured 13-20.9-29 μ, and toxas which measured 26-33.8-42 μ.

Order (?) Halichondrina Vosmaer

The order is not established firmly and is open to severe criticism. It was discussed by de Laubenfels (1953a: 530) who suggested that the order should be dropped and "most or all of its families be merged with those of the Poecilosclerina." De Laubenfels, however, followed the established classification. It is followed here also.

Family Axinellidae Ridley and Dendy

Axinella polycapella de Laubenfels, 1953. —Beachworn specimens were found at Station 12 during 1957. The species was taken also at Stations 18, 20, 21 and 22 in 1948 and described by de Laubenfels (1953a: 530). It is not now represented by a specimen.

The spiculation of this species is principally of oxeas though a few styles may be found; in addition, two strongyles were found, one 205 x 11 μ from the axis, and the other 168 x 10 μ from the outer area. The spicules measured in the axis consisted of oxeas 230-260.8-297 x 9-10.9-15 μ and two styles 240 x 11 μ and 249 x 12 μ. The oxeas of the outer areas were smaller on the average, measuring 182-243.3-307 x 2-8.2-12 μ, as were the only two styles found. They were 192 x 14 and 187 x 17 μ.

These measurements indicate a greater range in spicule size than is recorded by de Laubenfels; also, the axis seems to have larger spicules than the outer portion. Nevertheless, because of overall morphological agreement, both macro- and microscopic, the specimens are placed here with confidence.

Homaxinella waltonsmithi de Laubenfels, 1953.—This flabellate or palmate sponge was not found during the course of the present investigation but was taken at Station 20, October 26, 1948. It was described originally from the area by de Laubenfels (1953a: 533).

Family Halichondriidae Gray

Halichondria panicea (Pallas, 1766) Fleming, 1828.—OI 1010, USNM 23566 (fig. 20). This sponge superficially is much like *Haliclona permollis* (de Laubenfels 1953b: 20), from which it is set apart by having a special dermal skeleton. It is basically amorphous with the oscules often on volcano-like protrusions 0.5 to 1 cm in diameter. The maximum size found was 20 cm in diameter x 7 cm high.

The color has been recorded as basically yellow (de Laubenfels, 1934), but the specimens found here ranged from light greenish-brown to light green in color, with one specimen pink. This wide range of color is characteristic of the species (de Laubenfels, 1953b). A particularly distinctive characteristic is that the spicules are spread about in confusion in the cavernous endosome. However, in the present specimens there were some vague tracts containing 5 to 8 spicules in cross section. The skeleton is made up exclusively of oxeas with great variation in

Figures 19-20. **19** (top) *Merriamium tortugasensis* de Laubenfels (USNM 23561). **20** (bottom). *Halichondria panicea* (Pallas) Fleming (USNM 23566).

size. In this case they were between 73 x 2 and 575 x 12 μ.

Because of the similarity between *H. panicea* and *H. bowerbanki* Burton (1930), the specimens collected were examined in detail in regard to the dermal reticulation and sizes of dermal and endosomal spicules. Hartman (1958: 33-34) pointed out that *H. panicea* has "a very regular network of multispicular tracts" with occasional spicules lying across the oblong areas made by the tracts, while *H. bowerbanki* is different; its multi-spicular tracts "when present, are widely spaced and divide up the dermis into larger areas, . . . further subdivided by a pattern of overlapping individual spicules." In addition he pointed out that the dermal spicules of *panicea* are smaller than those

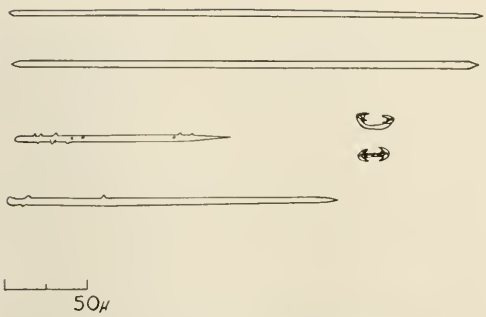


Figure 21. Spicules of *Merriamium tortugasensis* de Laubenfels.

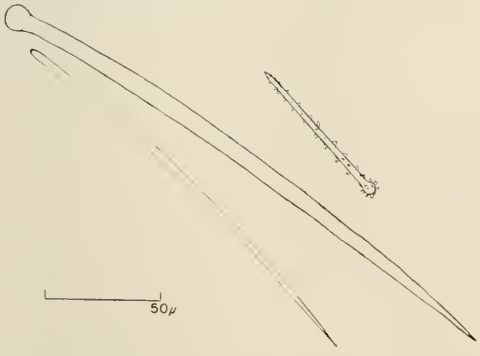


Figure 22. Spicules of *Eurypon clavatella*, sp. nov.

of the endosome while dermal spicules of *bowerbanki* are the same size or larger than the endosomal ones.

Concerning Hartman's first difference, I must point out that while he seems to be right, the judgment must be made extremely cautiously and after several dermal areas of the specimen have been observed. Individual areas or fields of *panicea* may closely resemble *bowerbanki* and probably the reverse is also true.

Dermal spicule size also may be variable. The average size of the dermal spicules in various specimens was from 1.0 to 74.2 μ smaller than the endosomal ones, the mean average difference being 37.7 μ. Another specimen collected at the same spot as the specimen with the least difference showed an average difference of 55.5 μ. The mean length of the endosomal spicules ranged from 307 to 409 μ, while the dermal spicule average ranged from 264 to 364 μ, thus showing the great variability of the specimens within the species.

The species was found in abundance during the fall of the year at Stations 2 and 11, and at a depth of 5 meters in the Panama City area. Substrate was either sand or grass

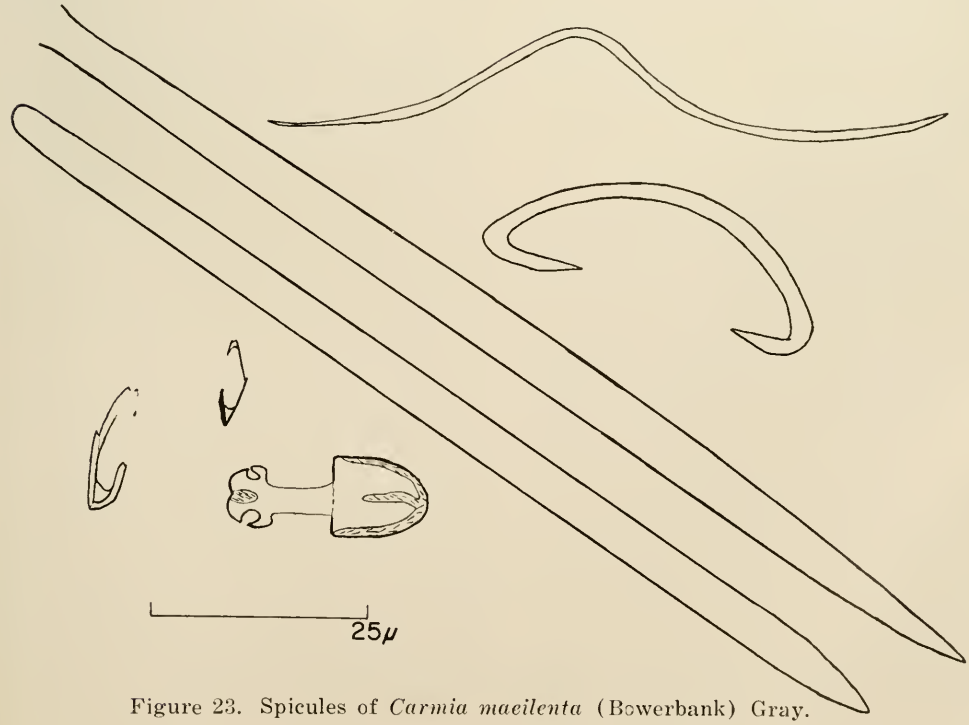


Figure 23. Spicules of *Carmia maeilenta* (Bowerbank) Gray.

flat. Data from seven specimens are represented.

Halichondria melanadocia de Laubenfels, 1936.—OI 1022, USNM 23590. This very dark brownish, amorphous sponge was taken from a steel buoy opposite the Shipyard in Panama City by staff of the Florida State University Oceanographic Institute. It had a few small finger-like processes extending from the surface. These were about 1 cm high and 0.5 cm in diameter. Its skeleton and architecture placed it in the genus *Halichondria*. The spicules were oxeas 144 x 2 to 460 x 13 μ. The mean size of the endosomal ones was 308.0 x 8.7 μ and the mean size of the ectosomal spicules was 320.5 x 7.4 μ. In view of the great range of size the difference between the means is not considered significant; the overall mean size is 314.3 x 8.0 μ. This greatly overlaps the range given by de Laubenfels (1936a: 134).

Family SEMISUBERITIDAE de Laubenfels

RHAPHISIA **MENZELI**, sp. nov.—OI 1042, USNM 23588 (fig. 24).

The holotype of this species is designated as USNM 23588.

Locality and abundance.—One specimen, taken at Station 2, Bay Mouth Bar, Alligator Harbor, on March 4, 1957. Depth was 1.5 meters and substrate was sand.

Shape and size.—Basically a sub-spherical mass 3 cm in diameter and 2 cm in height.

Color.—The exterior was lavender to a depth of about 0.5 cm. The interior was brown.

Consistency.—Soft and spongy.

Surface.—The surface was covered with closely set lamellate projections, like flattened conules, each in turn bordered by minute conules less than 1 mm in height. The lamellate projections generally were less than 1 mm apart. The overall appearance was fuzzy.

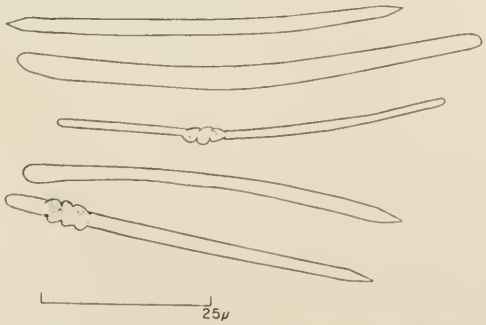


Figure 24. Spicules of *Rhaphisia menzeli*, sp. nov., showing two spicules centrotylote as is occasionally the case with each type.

Oscules.—One oscule was partially hidden by the encircling projections or lamellate conules; it was 3 mm in diameter. The oscules were difficult to locate due to the nature of the surface.

Odor.—Even in alcohol there was a distinct fetid odor about this sponge.

Ectosomal anatomy.—No specialization; the spicule tracts from the endosome entered the lamellate protrusions and branched to form their skeleton.

Endosomal anatomy.—The endosome was microcavernous and confused. There were primary spicule tracts ascending to the surface. These contained 10 to 12 spicules per cross section and ranged from 38 to 46 μ in diameter. There were also secondary tracts containing 3 to 7 spicule rows, 15 to 23 μ in diameter. The secondary tracts were sometimes parallel, and sometimes vertical, to the surface, very close to a primary tract and connected to it by a trellis of spicules. These trellises sometimes appeared to create a curious entwining effect between the two tracts. The random crossings of these tracts formed meshes 70 x 70 to 535 x 460 μ. The flesh was confined to the region of tracts or interconnecting spicules.

Skeleton.—The spiculation may be regarded as being comprised of a single category but with much individual variation. Some were simple, smooth, sharp-pointed oxeas 75-106-178 x 3-4-5 μ, while others which might be considered immature or microxeas were 89-94-98 x 1-1.3-2 μ. The larger spicules frequently had a wide variation of shape. Not uncommonly they were centrotylote, and some were also stylote and strongylote.

Discussion.—All the sponges now in *Rhaphisia* except the type species, *R. laxa* Topsent (1892, xvii), and *R. myxa* de Laubenfels (1951: 263), from Hawaii, have much larger spicules than those of this specimen. *R. myxa* is clearly closest to the Gulf form in physical characteristics, differing primarily in color, mesh size, and smooth surface. The viscous nature of both of the above species was not particularly noted in this specimen, possibly because it was received preserved in alcohol.

The species is named in honor of Dr.

R. Winston Menzel of the Oceanographic Institute, Florida State University, who inspired and helped greatly in the completion of this work.

Family Hymeniacidonidae de Laubenfels

Hymeniacidon heliophila (Wilson, in: Parker, 1910) de Laubenfels, 1936.—OI 1013, USNM 23581. This orange-pink sponge was found thickly encrusting on the stone jetties at St. Andrews State Park, Panama City, Florida, throughout the year. The elongate, conical processes characteristic of the species (de Laubenfels, 1950a; Parker, 1910) were not in evidence except for slightly elevated rounded protrusions. Patches of the sponge 20 cm in diameter and 2 cm in height were found. In some places it was so abundant that it practically covered the surface of the rock. The broad area of attachment and the tidal currents in the channel undoubtedly were responsible for this variation of shape.

The skeleton was composed exclusively of styles 128-278-345 x 2-4-5 μ. These spicules were somewhat smaller than usual. The nature of the conulose surface, the color, and the structure, identify the specimens as *H. heliophila.*

It was redescribed by Wilson (1911), George and Wilson (1919), de Laubenfels (1936a, 1950a), and by Wells *et al.* (1960).

Order Hadromerina Topsent
Family Spirastrellidae Hentschel

Spheciospongia vesparia (Lamarck, 1814) Marshall, 1892.—OI 997, USNM 23547, USNM 23580. This is the common "loggerhead sponge" of the Tortugas. It is massive and cake-shaped, growing as large as 60 cm in diameter and 40 cm high. Consistency when wet is cork-like, but after drying the sponge becomes woody. The color is creamy brown to dark brown. The spiculation consists of tylostyles averaging 386 x 9 μ (range 214-482 μ), and rare spirasters, mean length 13 μ (range: 9-18 μ). Most of the spirasters had three contortions or bends.

It was found abundantly throughout the year at Stations 1 and 10, and was also recorded from Stations 20 and 21 (de Laubenfels, 1953a) thus giving a depth range in this area between 2 and 13 meters. Substrate is rock, generally soft limestone of the Tampa type.

This species was redescribed in detail by de Laubenfels (1936a: 140).

Spirastrella coccinea (Duchassaing and Michelotti, 1864) de Laubenfels, 1936.—OI 1033, USNM 23598. This thinly encrusting, red-brown to orange sponge fades to grey or white in alcohol. Its spiculation is of tylostyles plus abundant spirasters in the cortex (de Laubenfels, 1936a: 143).

Several small patches, 1 cm in diameter and 1 to 2 mm in height, were found on pieces of limestone dredged at Station 7, November 3, 1957, depth 9.5 meters. The color was orange in life.

The tylostyles were 134-227.5-287 x 3-4.2-5 μ in size while the spirasters averaged 16 μ (range: 9 to 40 μ) though only one was found of the largest size. In general the maximum seemed to be about 24 μ. Thus the megascleres seem to be smaller than de Laubenfels' (1936a) 6 x 360 μ record while the microscleres are larger than his 12 x 2 to 20 x 4 μ report. In addition the spirasters, while abundant in the sponge, did not "pack" the ectosome as he indicated.

These differences do not seem great enough to justify describing it as new; therefore it is left here with some reservation.

Spirastrella coccinopsis de Laubenfels, 1953.—This was not found during the course of the present investigation but was taken at Station 20 on October 26, 1948, and reported by de Laubenfels (1953a: 537) as a dubious new species. He indicated that it may be synonymous with *S. coccinea* since it differs primarily in color and size.

Anthosigmella varians (Duchassaing and Michelotti, 1864) de Laubenfels, 1936.—OI 1032, USNM 23594. This dingy brown sponge has a multitude of shapes, sometimes elongate and cylindrical, at other times massive or amorphous. Its consistency was compared to that of cheese by de Laubenfels (1949a).

The spiculation was reported by de Laubenfels (1949a: 19) as consisting of tylostyles 360 x 6 μ, typical spirasters, and spirasters that are essentially C-shaped with blunt, knob-like protrusions arranged only along the convex side. It is reported as a hard sponge to identify because often these "typical C-shaped" spirasters are rare or even wanting, though in some cases they do form

the bulk of the microscleres (de Laubenfels, 1953a: 539).

This sponge was found at Station 7, depth 9.5 meters, on a rock bottom. It was grey and formed (encrusted) around a worm tube. In alcohol its color was drab brown or brownish grey.

The spiculation was somewhat different in the endosome and ectosome. The tylostyles of the endosome were 278-376.4-460 x 4-5.7-7 μ while those of the ectosome were smaller, measuring 240-326.2-412 x 4-5.3-7 μ. In addition, the normal spirasters of the endosome, 7-19.3-31 μ, were larger than those of the ectosome which were 4-13.0-31 μ. The C-shaped spirasters were confined largely to the ectosome, only a few being found in the endosome. They were 7-9.9-15 μ in size.

The species also was recorded from Station 20 on October 26, 1948, by de Laubenfels (1953a).

Halicometes stellata (Schmidt, 1870) Topsent, 1898.—USNM 23571. Small portions of this species were collected in the Panama City area by Dr. Meridith Jones during the early part of 1958. The specimens were encrustations, 0.5 to 1.5 cm in diameter and 2 to 5 mm in height and are numbered I-II and 3E3 in Dr. Jones' collection. No color or ecological data were available for these specimens.

Because of the small size of the specimens, virtually all of the material was used in making sections and spicule mounts.

The tylostyles, a few of which tend to be stylote, were 211-569.1-1015 x 3-7.1-12 μ which is in good agreement with de Laubenfels' (1950a: 99) Bermuda report, though the microscleres were somewhat larger than he reported. The oxyspherasters averaged 26.4 μ (range: 18 to 33 μ), while the chiasters averaged 12.8 μ (range: 7 to 22 μ).

The minute size of the specimens and the difference in microsclere size lead the author to place this sponge here with some reservation.

Family Placospongiidae Gray

Placospongia carinata (Bowerbank, 1858) Vosmaer, 1902.—OI 1043, USNM 23582 (figs. 25, 27). This is an encrusting species whose surface is hard, almost stony, and is divided by cracks and ridges into roughly polygonal areas. It was common at Station 10, depth 3 meters, encrusting on limestone in patches up to 10 cm in diameter and 3 mm thick. It was collected August 13, 1957.

Color in life was orange, while in alcohol it was brown. The surface was relatively smooth, but broken up by the above-mentioned polygonal plates, about 12 x 20 mm in size. The cracks along the raised ridges which separated the polygonal areas were about 1 mm wide and were assumed to contain both oscules and pores.

The ectosome consisted of a dense, stony cortex of microscleres firmly bound together by fibrous or protoplasmic structures. The endosome, what little there was, contained tracts of megascleres which penetrated the base of the cracks, thinned out, and finally lined the wall of the lumen which was formed by the edges of the crack coming together at its apex. These tightly packed megasclere tracts were about 350 μ in diameter in the endosome and thinned to about 125 μ across the narrow neck of the crack, before it widened in the ridge area to form the lumen. After following the walls of the lumen, the thin megasclere tracts came together in the opening of the crack to form a thick mass of megascleres and finely microspined spirasters which looked as if they were too large for the opening and thus folded back into the lumen, forming another smaller lumen within the spicule mass. The diameter of this mass in the crack mouth was 285 to 385 μ. Sections look similar to Vosmaer's figure (1902: Pl. II, fig. 5).

The megascleres were tylostyles averaging 729 x 10 μ (range: 359 to 910 μ). The main, cortex-building microsclere was a selenaster, mean size 57 x 68 μ (range in diameter: 53 to 76 μ). Selenasters look similar to sterrasters but arise in a different fashion. Juvenile selenasters appear as two basic types of spirasters: the first is finely microspined and varies in shape from a kidney bean to a short and often bent microstrongyle, size range 7-10-14 μ; the second is a somewhat larger, highly contorted spiraster with long, 4 to 9 μ, often dichotomous spines. Its overall measurements were 15-20-24 x 13-16-22 μ while the shaft was between 4 and 7 μ in diameter. In addition, there were all sizes of immature selenasters, some with long sharp spines and older ones with the spines shorter and seemingly more closely packed.

De Laubenfels (1936a: 153) reported *P. melobesoides* Gray from the Tortugas but since his specimen showed only a few tylostyle fragments and mature selenasters, his identification was only tentative. Possibly he actually found a specimen of this same species though this is impossible to tell from his slide.

P. carinata heretofore has been reported only from the Indo-Pacific (see Vosmaer and Vernhout, 1902) and from Madagascar (Levi, 1956b). In view of this distribution possibly we might be dealing with a new species. However, because of close agreement with descriptions of previous workers, this sponge is tentatively placed here.

Family CLIONIDAE Gray

Cliona celata Grant, 1826.—OI 999, USNM 23567. This is the common yellow boring sponge of the region, which outgrows its burrows to form tall, massive, cylindrical, papillate chimneys. Its galleries are 1 to 4 mm in diameter. Its papillae are the same diameter and 1 to 4 mm in height. Its skeleton consists entirely of tylostyles which, in this case, were 285-372-399 x 5-7-9 μ.

Early authors sometimes mentioned spirasters in connection with young specimens, but Old (1941) found none and redescribed the species with the megascleres only. De Laubenfels (personal communication) field-identified some of these specimens as *celata* rather than *C. caribboea* Carter. He also described both species for field identification (1953b).

The species was found abundantly throughout Alligator Harbor and vicinity and was taken specifically at Stations 1, 2 and 3. Depth in no case was over 2 meters.

Cliona caribboea Carter, 1882.—This species was not found during the present investigation but was taken at Station 21 on October 27, 1948, and reported by de Laubenfels (1953a).

It is much like *celata* and may be mistaken for it. The main distinguishing character is burrow or papilla size, which is on the average much coarser. The burrows and papillae reach a diameter and height of 4 to 6 mm, or about 2 mm larger than those of *celata* (de Laubenfels, 1936a, 1953b). The spicule size is about the same, though *caribboea* is reputed to have slightly thinner tylostyles (de Laubenfels, 1950a).

Cliona truitti Old, 1941.—OI 1024, USNM 23568. This boring sponge was collected from oyster reefs in Alligator Harbor, Station 3, by Dr. R. Winston Menzel. It was boring small holes and galleries 1 to 2 mm in diameter in the shell of *Crassostrea virginica* Gmelin at an intertidal depth.

The skeleton was composed of tylostyles 142-180-212 x 4 μ, finely spined microxeas 68-90-109 x 2-4-5 μ, and finely spined spirasters 7-11.2-14 x 2-2.4-4 μ which often were distinctly angulated one to three times, but sometimes straight.

Cliona vastifica Hancock, 1849 (?).—OI 1025, USNM 23569. This is a boring sponge found on an unidentifiable beachworn fragment of shell at Station 2, Bay Mouth Bar at Alligator Harbor, during October, 1956. It was found by Dr. R. Winston Menzel and Mr. R. T. Damian. Depth was intertidal.

Papillae protruding from the galleries were 0.5 to 1 mm in diameter and less than 1 mm high.

The megascleres were tylostyles 153-245.5-278 x 3-4.8-7 μ. The microscleres were composed of finely spined or smooth microxeas and spirasters. The microxeas were 64-84.2-115 x 2-2.6-4 μ while the spirasters were 11-24.2-29 x 2-2.4-3.3 μ (shaft diameter) and were distinctly angulated one to four times.

Although the tylostyle and microxea dimensions neatly fit Old's (1941: 11) tabulation, the spirasters seem slightly too large. In addition, the specimens I have examined of *vastifica* had fairly fine microspines on the spirasters, but in this specimen the microspines on the spirasters were so coarse that they almost doubled the diameter of the spiraster at points where they occurred. For this reason this sponge is only tentatively placed here.

Cliona lampa de Laubenfels, 1950.—OI 1023, USNM 23591. This is a boring sponge which permeates the substrate instead of excavating galleries as other boring sponges do. The color is a distinctive brick red.

The species was reported by de Laubenfels (1953a) from Station 22 and was found also during the course of the present investigation at Station 1, August 4, 1957, by the author. It was identified immediately in the field by the late Dr. M. W. de Laubenfels who was accompanying the expedition. Its host in this case was a large coral, *Siderastrea siderea* (Ellis & Solander), which looked

normal except that it was red to a depth of about 0.5 cm instead of being its usual yellow-brown color.

The skeleton consisted of tylostyles 153-210.7-240 x 2-3.9-6 μ with heads 4-5.8-7 μ in diameter, and abundant microscleres of two categories. There were finely microspined microxeas 77-92.0-105 x 2-2.4-3 μ and straight streptasters 5-8.1-13 x 1-1.9-2.2 μ. These size ranges greatly overlap those given by de Laubenfels (1950a: 110) in his original description. They are, however, somewhat larger than his. In view of the permeating habitus, straight spirasters, and de Laubenfels' previous record in the area, the differences are not sufficient to justify designation as a subspecies.

The skeleton of this species is similar to that of *C. vastifica* and might be mistaken for it. The primary differences are the permeating, as against excavating, habitus and the straight streptasters of this species. The spirasters of *vastifica* are distinctly angulated.

Cliona viridis (Schmidt, 1862) Gray, 1867. —OI 1029, USNM 23593 (fig. 28). This is a light yellowish-brown, thickly encrusting to amorphous sponge, soft in texture, whose base dimensions were 3 x 2 cm and height was 1 cm. It held much shell detritus, especially near the base, which may have been there as substrate. The spiculation consisted exclusively of tylostyles 210-296-440 x 1-5-7 μ whose heads averaged 8 μ (range: 4 to 11 μ diameter). There were no microscleres.

The specimen was found in Alligator Harbor in the vicinity of Station 3, depth 1 meter, on March 4, 1957, by Mr. Raymond T. Damian.

This sponge was described as *Suberites undulatus* by George and Wilson (1919: 140) from Beaufort, N. C. It was placed *incertae sedis* by de Laubenfels (1947: 34), primarily because no specimens could be found during his stay at Beaufort. He noted also that dead specimens of *Microciona prolifera* that have lost their flesh spicules would come to a residual spiculation approaching that of *S. undulatus*.

The most striking, and only important difference so far noted, is that of color. George and Wilson's specimen was light grey while this one is a light yellowish-brown. This difference is not considered significant and the specimen was identified originally as *S. undulatus*.

The finding of George and Wilson's original type specimen of *S. undulatus* by Wells *et al.* (1960: 232) and their subsequent synonymizing it with *Cliona viridis* necessitates placing my specimen here.

Order Epipolasida Pallas
Family Tethyidae Gray

Tethya aurantia (Pallas, 1766) Topsent, 1900.—OI 1020, USNM 23577. This was an orange, subspherical, tuberculate sponge 4 to 6 cm in diameter and the same in height. The endosome was olive-drab in color.

The megascleres were strongyloxeas and small styles, some of which showed the subtylostylote modification. The strongyloxeas in the ectosome averaged smaller than those of the endosome, though their range was greater. The styles were confined to the ectosome.

The mean size of the ectosomal strongyloxeas was 1221 x 21 μ (range: 765 to 1828 μ), while the endosomal ones averaged 1326 x 25 μ (range: 1010 to 1775 μ), though a few immature strongyloxeas were found here averaging 553 x 7 μ. The styles were 144-253.4-452 x 4-7.9-11 μ.

The microscleres were composed of spherasters, 32-76-107 μ in diameter, microspined chiasters 9-13-18 μ, and microspined oxyasters 12-17-25 μ.

This species was abundant throughout the year at Station 10, depth 2.5 meters, on a limestone substrate. The species also was reported from Station 1 but this station is not now represented by a specimen.

The specimens are placed here because of the small styles which characterize the ectosome. Only one other species, *T. extensa* Hentschel, from Australia, has styles of the same order of magnitude as this species, but the spicules of *extensa* are fully 200 μ longer than those of the Apalachee Bay specimens.

Order Choristida Sollas
Family Ancorinidae Gray

Unimia trisphaera de Laubenfels, 1953.—This spherical, dark mahogany sponge was not found during the course of the present investigation. It was reported from Station 20 only where it was taken October 26, 1948. It was described by de Laubenfels (1953a: 546).

Stelletta grubii Schmidt, 1862.—OI 1004,

USNM 23575, USNM 23603. This is the "oyster sponge" which plays host to, and probably protects from fouling organisms, the sponge oyster *Ostrea permollis* Sowerby. This relationship first was recorded by the author (1958). This sponge is mistaken easily for *Geodia gibberosa* (Lamarck) which was erroneously reported to play host to the oyster (Menzel, 1957). It is easily distinguished from *Geodia* by its lack of sterrasters in the cortex. All oyster sponges collected to date have been this species. It is common throughout the year at Stations 1, 2, and 4, and was collected previously at Station 20 (de Laubenfels, 1953a). Depth range is 1 to 13 meters.

The skeleton of this species contains very long oxeas, plagiotriaenes and anatriaenes as well as a microsclere population containing finely microspined oxyeuasters plus eutylasters which are finely microspined at the tips of the tylote-ended rays. The megascleres of the ectosome were a little longer than those of the endosome while the microscleres of the ectosome were smaller than those of the endosome.

In the ectosome the long oxeas were 1100-1317-1560 x 12-27.6-36 μ. The plagiotriaenes were 815-984-1170 x 10-23.2-38 μ with clads 48-79.5-105 μ long. Only one anatriaene 1416 μ long was found, while the shaft diameter on broken individuals was 10-13.2-19 μ and the clad length was 38-59.4-86 μ. The fairly rare oxyeuasters were 4-11.5-15 μ, while the eutylasters were 11-12.1-18 μ.

In the endosome the oxeas were 885-1258-1450 x 9-18.1-38 μ with plagiotriaenes 565-906-1100 x 9-15.4-34 μ, clads 29-60.4-96 μ, and anatriaenes 675-1062-1415 x 10-14.5-29 μ with clads 19-45-86 μ long. The oxyeuasters were 7-12.9-22 μ and the eutylasters were 11-16.3-22 μ in diameter.

This species was redescribed in detail by de Laubenfels (1950a) from Bermuda.

Family Geodiidae Gray

Geodia gibberosa Lamarck, 1815.—OI 1015, USNM 23564. This massive to lobate, basically dirty-white sponge was abundant at Stations 4, 7, and 11 throughout the spring and fall. It is often a mass of knobby fist-like projections up to 50 cm in diameter with individual knobby projections measuring up to 10 x 5 x 20 cm high. The projections are often packed closely together and the effect is somewhat like a bushel of potatoes, closely packed, all standing on end.

The megascleres consisted of huge oxeas well over 1.5 mm, most of which were broken; orthotriaenes or plagiotriaenes with rhabds over 1 mm long but also broken, with clads 23-46 μ long; protriaenes all over 1 mm but broken, with clads 130-230 μ long; and, in one specimen, tylostyles 107-162-290 x 1-3-4 μ, and styles of mean size 225 x 5 μ (range: 205-246 μ).

The microscleres were composed of sterrasters (mean diameter: 62 x 60 μ; range 53-69 μ); oxyeuasters 12-18-21 μ; and oxyasters 4-6-9 μ in diameter.

This species was collected also at Station 20, October 26, 1948, and reported by de Laubenfels (1953a: 551). The species was redescribed in detail by de Laubenfels (1936a, 1950a).

We do not know at present whether the sponge oyster invades this species, as previously reported. Extensive collections and experiments are being carried on at the Oceanographic Institute, Florida State University, by Mr. Milton Forbes to determine the exact relationship between oyster and sponge, and the degree of specificity which governs it. As previously reported in this paper, *Ostrea permollis* has so far been found only in the sponge *Stelletta grubii* in this area. A few specimens of the sponge without the oyster also have been taken.

Family Craniellidae de Laubenfels

Cinachyra alloclada Uliczka, 1929.—OI 1048, USNM 23597. The shape of this species is recorded as sub-spherical and its color is recorded as yellow (de Laubenfels, 1936a).

One specimen was taken at Station 13 from sand and mud bottom, March 10, 1957, by N. Hulings and A. N. Sastry.

The shape of this specimen was like that of a child's top, with a convex upper surface. It appeared to be a piece ripped out of a spherical sponge, including the rounded surface and part of the endosome which tapered to a point, showing the radiate structure of the sponge nicely. Size was 3.5 cm in diameter and 3 cm in height (*i.e.*, radius to apex of pointed part of endosome). Color was yellow-brown; it faded somewhat in alcohol.

The convex upper (outer) surface was covered with numerous large pits 1-3 mm in diameter and 4 mm or more in depth.

The skeleton consisted of huge oxeas, sinuous broken-up anatriaenes, and protriaenes of about the same length as the oxeas. There were two sizes of oxeas found; the first averaged 3094 x 28 μ (range: 2731-4552 μ), and the second had a mean size of 1414 x 9 μ (range: 1155-1683 μ). The anatriaenes had clad lengths measuring 38-61-99 μ while the protriaenes had clad lengths measuring 64-84-180 μ. The microscleres were composed of sigmaspires with tylote ends 9-13-16 μ.

This specimen is placed here since the sigmaspires were within the 12-18 μ range of the species and because some of the triaenes were of the "Kudu" type (de Laubenfels, 1936a: 175). Had the range fallen into the 17-20 μ category and had the clads of the triaenes not been of the "Kudu" type, the specimen would then fall to *C. cavernosa* (Lamarck).

Possibly *alloclada* is conspecific with *cavernosa* as de Laubenfels suggested (1953a: 552), but in view of the distinctive spicule type which characterizes *alloclada,* I suggest keeping them separate until better evidence is available.

Figures 25-26. **25** (top). *Placospongia carinata* (Bowerbank) Vosmaer (USNM 23582). **26** (bottom). *Craniella crania* (Muller) Schmidt (USNM 23555).

Craniella crania (Muller, 1776) Schmidt, 1870.—OI 1012, USNM 23555 (figs. 26, 29). This species tends to be globular, but may take other forms in shallow water; my specimens are subspherical to semicylindrical in shape. Color is usually grey-brown or drab; the surface is usually hispid and often feels and looks like coarse, heavy felt. The structure is usually radiate internally.

The spiculation consisted of very long thin oxeas 444-881-1736 x 8-12-15 μ, and of anatriaenes and protriaenes in the same size range. Most were broken in slide preparation. In addition there was a microsclere population of sigmoid spirasters 11-13-16 μ. There were also enormously long, slender root spicule anatriaenes at the base of the sponge. They were 2 to 6 μ in diameter and had clads which measured 31-35.0-44 μ.

This species was found commonly at Stations 8 and 10, and one was also dredged at Station 14. This gives a depth range in this area from less than 1 to 6 meters, and a range in substrate from oyster shell to rock, and to sand.

This species was described in detail by George and Wilson (1919: 142) as *Tetilla laminaris,* which was made synonymous with *C. crania* by de Laubenfels (1947: 34-35). It was also redescribed under its correct name by de Laubenfels (1949b: 25). Wells, *et al.* (1960: 236) restored *laminaris* to specific rank as *Craniella laminaris,* differentiated from *C. crania* principally on the basis of growth form, color, and habitat, though the sigmoid spirasters were reported as slightly smaller than those of *C. crania.* I do not feel that such action is warranted on the limited qualitative impressions reported by them. More quantitative data are needed. For this reason I have taken what I consider to be the more conservative course since spiraster size and habitat, as indicated by the presence of root spicules, might indicate the specimen as *laminaris,* while color and shape do not.

CRANIELLA CINACHYRA (de Laubenfels, 1936) *new combination.*—OI 1021, USNM 23572 (fig. 30).

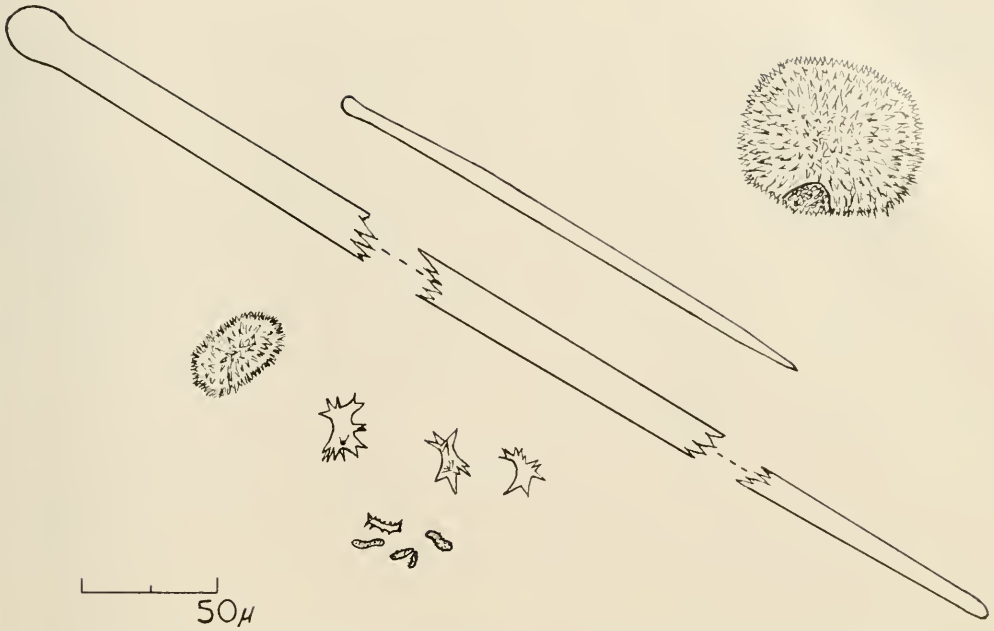


Figure 27. Spicules of *Placospongia carinata* (Bowerbank) Vosmaer.

This specimen was taken off Dog Island in 1956, perhaps in the region of the University of Miami Station 20. It was received in dry condition with no ecological data. It is an oval cake-shaped mass 10 x 8 cm in diameter and 3 cm high. Dry color is yellowish-gray. Technical difficulties and weather conditions prevented work off Dog Island during the course of the investigation and this species was not encountered again.

The megascleres consist of long oxeas, some of which were as thin as 4 μ and quite sinuous, and of prodiaenes and protriaenes 1.4-2.8 μ in diameter which appeared relatively rare. All the megascleres were over 1 mm in length; most were broken in the preparation of slides so that it was impossible to ascertain the total length. The microscleres are sigmaspires whose ends are slightly rounded, often tylote. Chord measurement indicated they were 7-9.4-11 μ in size.

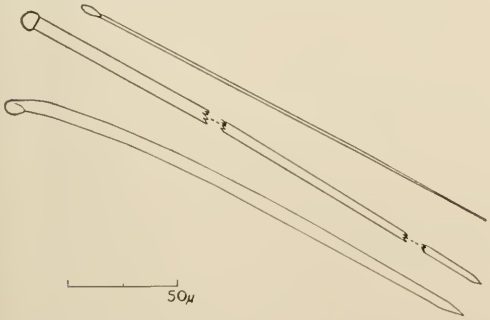


Figure 28. Tylostyles of *Cliona viridis* (Schmidt) Gray.

This specimen originally was identified as *Trachygellius cinachyra* by me and rechecked after the contention of Wells (personal communication) that there were triaenes in it which had been missed. Subsequent investigation yielded what are interpreted to be pieces of triaenes but only a few had unbroken, recognizable clads. The investigation of de Laubenfels' original section slide revealed the presence of triaenes, although in his spicule slides only fragments of triaenes could be found. I could not get any good data on the size of the anatriaenes in de Laubenfels' section, since they were within spicule tracts and had to be observed by focusing up and down; also, the section itself contains only three or four which can be demonstrated.

The above findings justify the transfer of this species to the genus *Craniella*. The lack of any anatriaenes in my slides presents some difficulty but the close morphological agreement between this specimen and my specimens of *C. crania*, with the exception of sigmaspire size, could easily lead one to

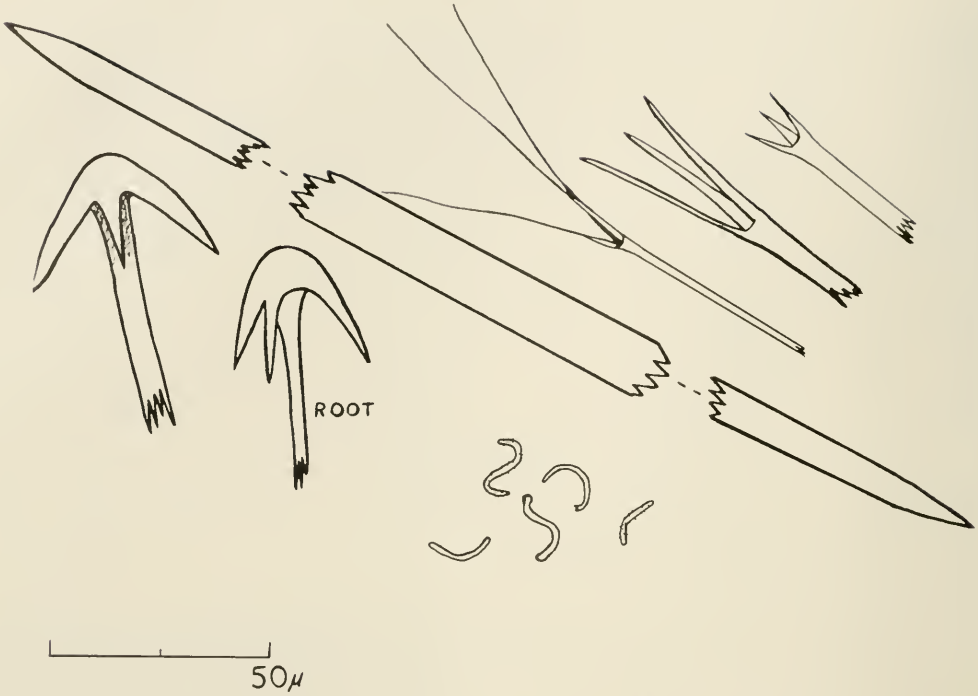


Figure 29. Spicules of *Craniella crania* (Muller) Schmidt.

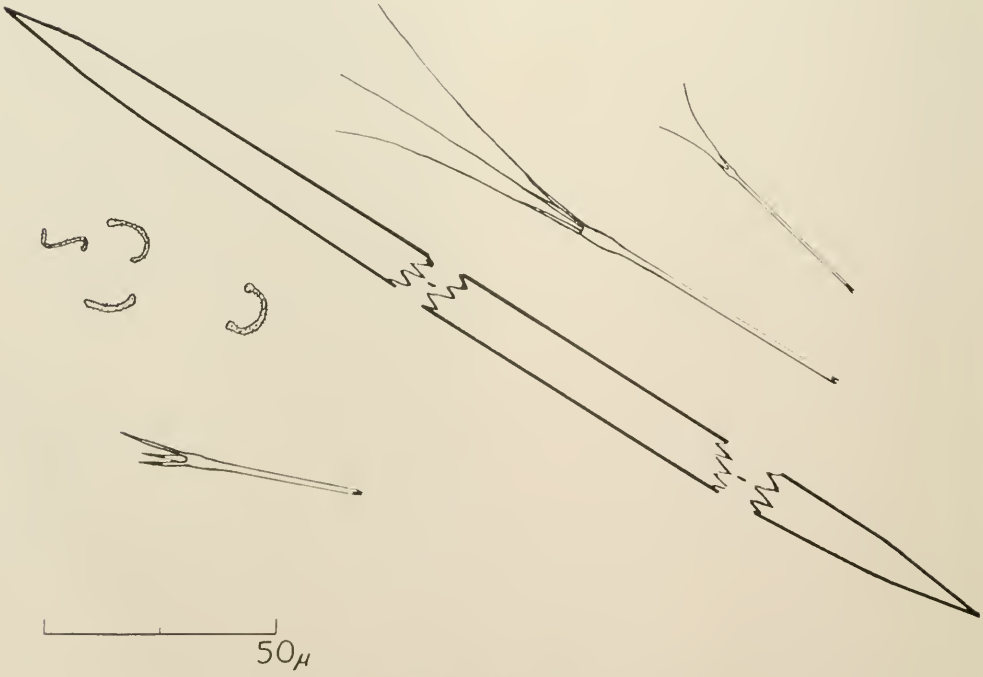


Figure 30. Spicules of *Craniella cinachyra* (de Laubenfels), new comb.

place it there. Indeed, possibly this species is conspecific with *C. crania.* This would go far toward explaining de Laubenfels' apparent error in identifying *cinachyra* as *crania* (Wells *et al.,* 1960: 233). At present however, I feel that the more conservative course should be followed until the problem is resolved clearly by further work.

The above discussion raises some question as to the finding of *Trachygellius cinachyra* by Wells *et al.* (1960: 233) off North Carolina. Those specimens should be reexamined for triaenes and their proper systematic position determined.

Order Carnosa Carter
Family Chondrillidae Gray

Chondrilla nucula Schmidt, 1862.—OI 1050, USNM 23599. This is the "chicken liver" sponge. It is flat to lobate in shape and does not look or feel like the usual concept of a sponge, but is smooth, slippery, and shiny. It has the consistency of cooked egg white or raw liver. The color is usually pale drab. It has no spongin skeleton and no megascleres; its only spicules are spherasters which in this case averaged about 30 x 20 μ in diameter (range: 14-36 μ). These spherasters were not round as is shown by the two axial measurements.

It was found on another sponge August 13, 1957, at Station 10, depth 3 meters, by Dr. John Morrill. The species was redescribed in detail by de Laubenfels (1950a: 133).

CLASS CALCISPONGIAE

Order Syconosa de Laubenfels
Family Scyphidae de Laubenfels

SCYPHA **ACANTHOXEA,** sp. nov.—OI 1035, USNM 23602 (fig. 31).

The syntypes of this species are designated as USNM 23602.

Locality and abundance.—Relatively abundant in the Panama City region and was found on steel buoys at a depth of less than 1 meter.

Shape and size.—A small cylinder or ball 2 to 5 mm in diameter and 1 to 4 mm long. The average size was 2 mm in diameter and 4 mm in length.

Color.—Greenish-white.

Surface.—Hispid.

Oscules.—Single, apical, 0.3 to 0.5 mm diameter.

Figure 31. Distinctive acanthose oxeas of *Scypha acanthoxea,* sp. nov. Other spicule types are not illustrated.

Flagellate chambers.—350 x 70 to 525 x 250 μ.

Ectosomal anatomy.—No specialization except for tufts of oxeas perpendicular to the surface. They are located in the distal ends of the flagellated chambers and give the sponge the hispid effect. There was no actual ectosome. The distal part of the flagellated chambers was naked, except for the spicule tuft.

Endosomal anatomy.—Triaxon spicules were strewn between the flagellate chambers forming a skeleton. The rays of some projected into the central spongocoel as did the rays of the few tetraxons present. The structure was typical of the genus.

Skeleton.—Six categories of spicules were present. There were three sizes of triaxons, some of which had at least one ray that was sinuous. Among them were a few tetraxons of the same size categories. The three sizes were measured on the basis of the length of their individual rays. Their ray lengths were: 58-144.7-220 μ, 58-90.1-115 μ, and 29-44.1-86 μ. In addition there were two classes of regular oxea, *i.e.* the dermal spicules. They were 527-727.6-1169 x 8.6-9.0-9.6 μ and 229-333.4-489 x 2-6.4-9.6 μ.

There was one further category of oxea: *i.e.,* with one end normal or slightly swollen and the other coarsely acanthose for about one-fourth the length of the spicule. The acanthose part varied from about one-tenth the length in long ones to a very short one that was virtually completely acanthose. These were 345-728.6-2299 x 3-4.3-7 μ. They are considered primarily coronal spicules though two or three have been seen

sticking into, and even completely through, the spongocoel.

Discussion.—There do not seem to be any other members of the genus that have oxeas or axon rays that match these specimens, nor are there any other members of the genus with such acanthose-ended oxeas. I think these traits constitute good criteria for designation of a new species. The species is named for the peculiar acanthose spicule which characterizes it.

Credit is due to Dr. Willard Hartman of the Yale Peabody Museum who first pointed out these queer, relatively rare spicules to me.

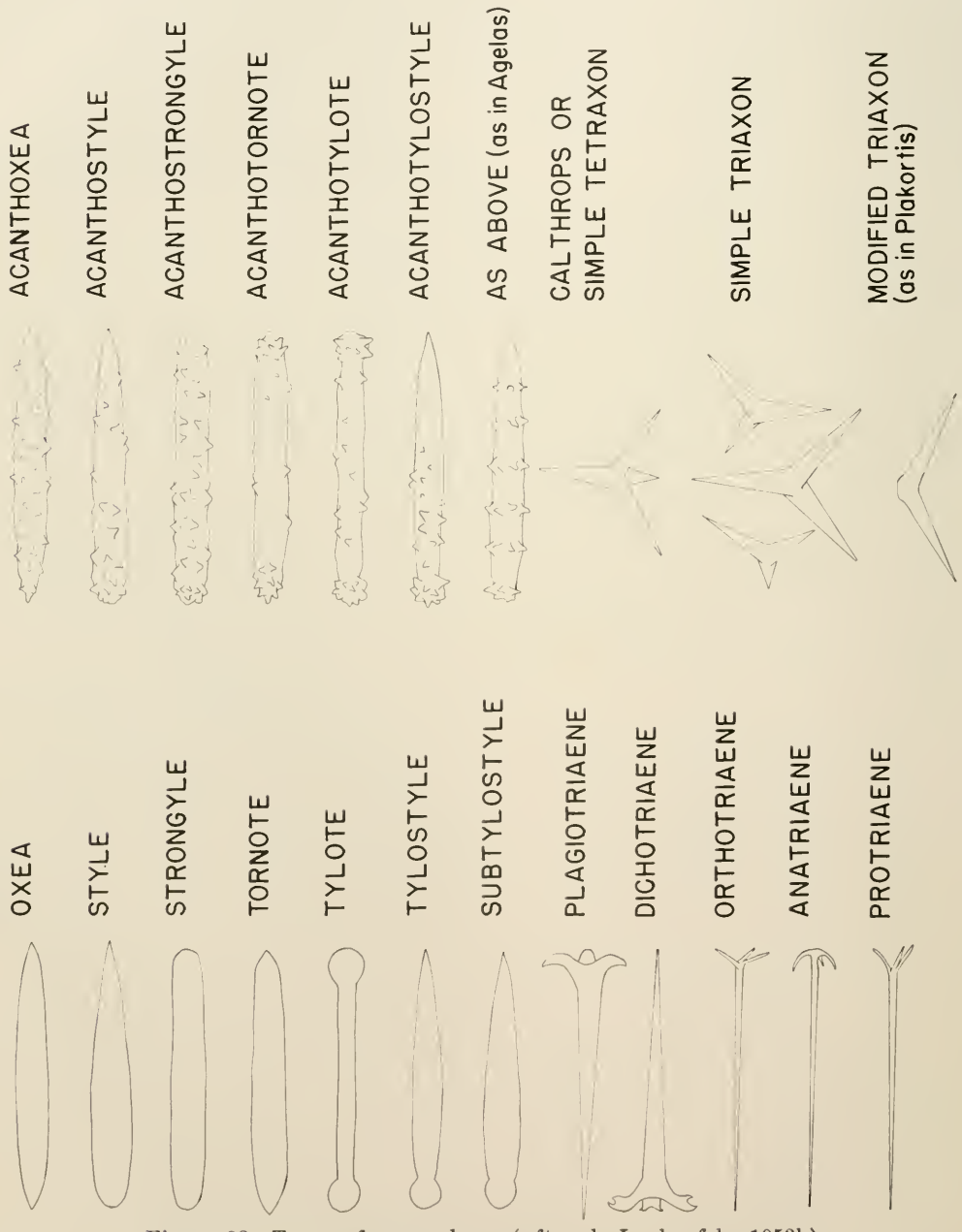


Figure 32. Types of megascleres (after de Laubenfels, 1953b).

Order Asconosa de Laubenfels
Family Leucosoleniidae Minchin

Leucosolenia canariensis (Miklucho-Maclay, 1868) Dendy and Row, 1913.—OI 1041, USNM 23600. This sponge's small yellow trellis-work of ascon tubes, each 1 mm in diameter, forms masses up to 3 or 4 cm in diameter. It is identified readily by its lemon yellow color which is retained in alcohol, and by its pronounced ascon structure. It contains only simple triaxon spicules.

The species was abundant at Station 10, depth 3 meters, on October 13, 1957, where it was growing on *Sargassum*. Identification was verified by de Laubenfels (personal communication).

This is the only record of the sponge for this area though de Laubenfels reported and described it from the Tortugas (1936a: 201) and Bermuda (1950a: 149).

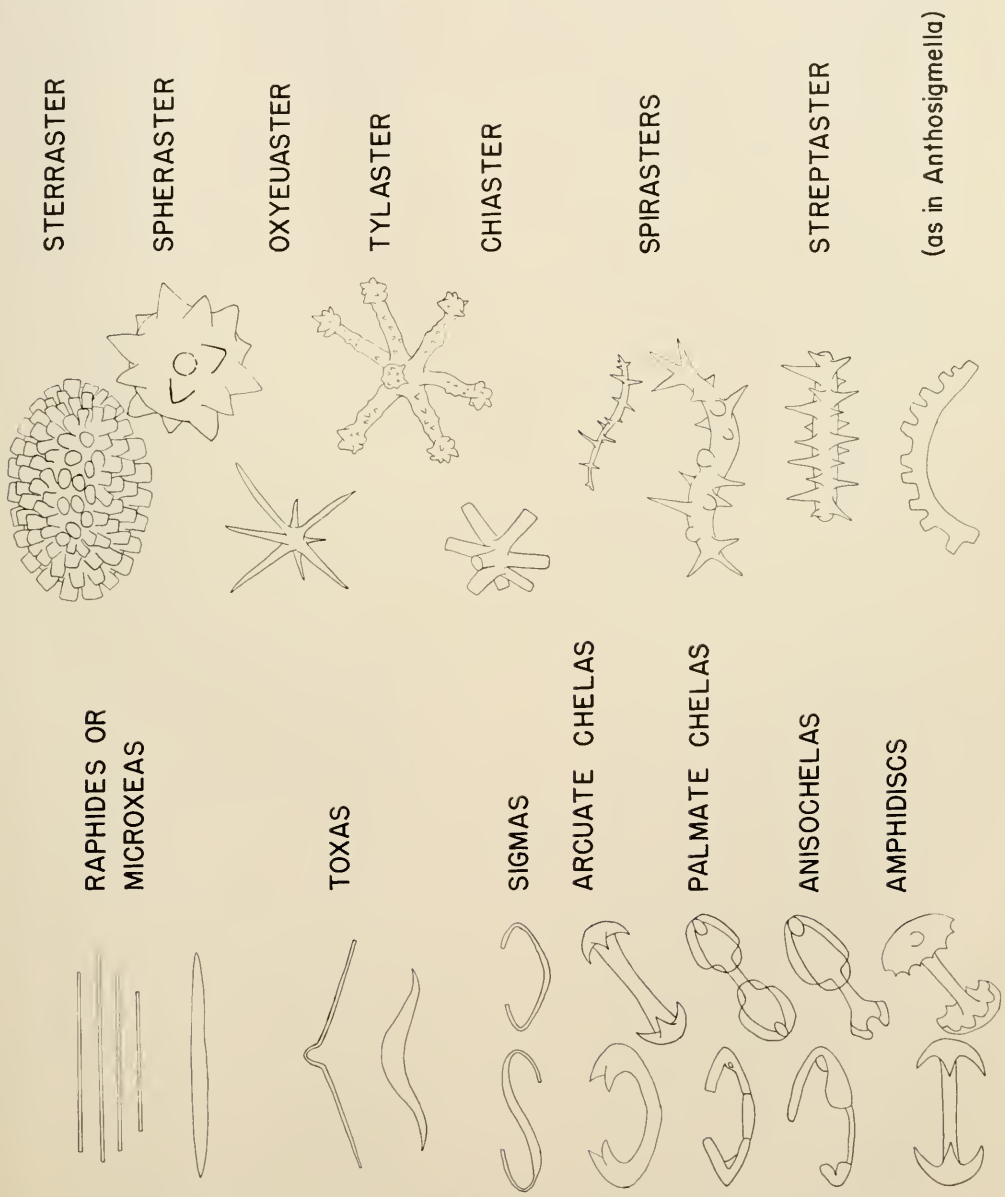


Figure 33. Types of microscleres (after de Laubenfels, 1953b).

V. Artificial Key to the Species

Most spicule types encountered are illustrated in Figures 32 and 33. De Laubenfels (1948, 1953b) and Hyman (1940) may be referred to for further explanation and illustration of the terms used in this key.

1. Proper spicules of silica or calcium carbonate present 19
   Proper spicules absent 2
2. Spongin fibers present 3
   Spongin fibers absent, color in life purplish-red, brighter than maroon ..... *Halisarca purpura*
3. Skeleton a network of fibers 4
   Skeleton fibers tree-like; they branch but seldom or never anastomose. Color dull red, shape massive to amorphous, triaxon spicules of spongin ..... *Darwinella joyeuxi*
4. Flagellate chambers spherical or ovate and small, generally 50 microns or less in diameter 5
   Flagellate chambers sack-shaped and large, generally over 50 microns in diameter 17
5. Fibers show little evidence of stratification or axial specialization, often opaque, often spongy when dry and may soften when returned to water 6
   Fibers markedly stratified, very evident axial specialization, often with pith; when once dry they remain hard and brittle permanently 15
6. Main fibers not trellised or fascicular 7
   Main fibers trellised or fascicular, persistently brittle once dry; sharply set off by the presence between the skeletal fibers of filaments akin to spongin, 3 to 10 microns wide and about 1 mm long; sponge has strong sulfur or garlic odor 12
7. Primary fibers "cored" with foreign material; secondary fibers not so cored 8
   Huge ramifying subdermal cavities, great emphasis on the uncored secondary fibers so that the primary (cored) fibers are rare or wanting 11
8. Normal structure and flesh in sponge; flagellate chambers normally placed 9
   Peculiar structure in that the flagellate chambers are scarcely more than holes punched in thin sheets of tissue ..... *Aulena columbia*
9. Shape subspherical with widely distributed oscules each on a lobate protrusion; color drab to black ..... *Spongia barbara*
   Shape massive to cylindrical 10
10. Shape tends toward being an inverted truncated cone; color drab to black ..... *Spongia graminea*
    Shape tends to be cylindrical to vase shape; color white with lavender tints ..... *Spongia* sp.
11. Long wall-like ridges between subdermal canals; considerable areas (over canals) that are relatively smooth valley-like plains ..... *Hippiospongia lachne*
    Areas between subdermal canals restricted to small island-like areas so that the surface appears covered by tubercles ..... *Hippiospongia gossypina*
12. Shape ramose to lobate; color brown to brownish white; conules 2 to 4 mm apart 13
    Vase or cake shape; conules 4 to 12 mm apart 14
13. Branch ends acute, or pointed ..... *Ircinia fasciculata*
    Branch ends bluntly rounded ..... *Ircinia ramosa*
14. Vase-shaped; reddish or white with reddish tinge; conules 4 to 8 mm apart ..... *Ircinia campana*
    Cake-shaped; grey; conules 6 to 12 mm apart ..... *Ircinia strobilina*
15. Exceedingly ramose; predominant color in life dull yellow though the upper side may be light brown; fibers contain a central conspicuous pith extending their entire length 16
    Ramose to amorphous or lamellate; color in life dark purple (may be covered with yellow sheen); fibers may appear slightly cored with foreign material (they contain distinctive small cells especially in the central pith region) ..... *Ianthella ardis*
16. Color in life dull yellow or grey, slowly turning reddish or carmine, or drab upon death or in alcohol ..... *Verongia longissima*
    Color dull yellow with upper side light brown, quickly turns dark purple on death or in alcohol ..... *Verongia* sp.
17. Both primary and secondary fibers cored with foreign material 18
    Primary fibers so cored, but secondary fibers clear; shape lobate to ramose; color light brown to rosy red ..... *Euryspongia rosea*

18. Color orange to pink-red ..... *Dysidea crawshayi*
Color sky blue ..... *Dysidea etheria*
19. Calcareous spicules present 20
Siliceous spicules present 21
20. Color greenish white; sycon with rare acanthoxeas ..... *Scypha acanthoxea*
Color yellow; asconoid ..... *Leucosolenia canariensis*
21. Megascleres as well as microscleres present 22
Only microscleres, spherasters present; color white, consistency cartilaginous; surface smooth and shiny like cooked egg-white ..... *Chondrilla nucula*
22. Tetraxons absent as megascleres 23
Tetraxons present as megascleres 60
23. Diactine megascleres present only 25
Monactines and/or diactines present as megascleres 24
24. Monactines and diactines present as megascleres 36
Monactine megascleres present only 42
25. Diactine megascleres only, no microscleres 26
Diactine megascleres plus microscleres 34
26. No dermal specialization; reticulation of endosome merely continues to surface 27
Dermal mesh or reticulation smaller, or a definite special dermal skeleton present 30
27. Skeleton of oxeas only 28
Skeleton mainly of oxeas, but with a strong tendency for the larger ones to be strongylote or stylote ..... *Haliclona* sp.
28. Sponge light green to grey-brown; encrusting to massive with digitate processes; oxeas about 120 microns long and some few may be strongylote or stylote ..... *Haliclona viridis*
Sponge lavender to brownish grey or red 29
29. Sponge brownish grey to lavender; thickly encrusting to massive and amorphous; oxea length averaging about 150 microns; skeleton regularly reticulate ..... *Haliclona permollis*
Sponge dull red even when dry; shape ramose ..... *Haliclona rubens*
30. Dermal mesh smaller than that of the endosome; sponge a light brown hollow tube with oxeas the only spicules ..... *Callyspongia vaginalis*
Definite special dermal skeleton, tangent 31
31. Sponge white or light brown fingerlike fistula rising from a flat basal mass; fistula 2-4 mm diameter and 2-4 cm high; skeleton consists of oxeas only; endosome wanting in the fistula giving it the form of a slender hollow tube ..... *Rhizochalina oleracea*
Sponge encrusting to massive or amorphous though it may have slender finger-like processes (less than 2 cm high) standing erect on its surface 32
32. Sponge white; encrusting with a few finger-like processes rising from the surface; skeleton of oxeas only, though some verge towards strongyles ..... *Adocia neens*
Sponge light greenish-brown (occasionally pink) to yellow, light green or brown 33
33. Color yellow to light green (occasionally pink) to light greenish-brown ..... *Halichondria panicea*
Color dark, brownish ..... *Halichondria melanadocia*
34. Megascleres are tylotes only 35
Megascleres are oxeas only; repent ramose; color yellowish green to cream; dermal mesh smaller than endosomal; spiculation of oxeas about 100 microns long plus microxeas and raphides, many of which are bent to simulate toxas ..... *Callyspongia repens*
35. Shape a small hollow fistula up to 5-7 mm in diameter about 1 cm high; spiculation of tylotes, arcuate isochelas and sigmas; color white ..... *Coelosphaera fistula*
Shape amorphous with conical elevations; spiculation of tylotes; arcuate verging to palmate isochelas; two sizes of sigmas; color bright orange ..... *Xytopsene sigmatum*
36. Diactine and monactine megascleres only, no microscleres; color bright red to orange-red; shape ramose; distinct axial modification in branches: spiculation of styles and oxeas ..... *Axinella polycapella*
Diactine and monactine megascleres plus microscleres 37
37. Tylotes comprise part of megasclere population 38
Tylotes not found as part of the megasclere population 39
38. Color orange to pink-red; shape encrusting to massive; spiculation of tylotes and styles

(which may be subtylostylote to a slight extent) plus roughened raphides as microscleres ... *Tedania ignis*

Exterior color yellow to brownish-green; interior color yellow; shape permeating to encrusting and sometimes massive and amorphous; spiculation of tylotes and slightly bent styles plus sigmas and arcuate isochelas as microscleres ... *Lissodendoryx isodictyalis*

39. Megascleres comprised of tornotes and acanthostyles, plus arcuate isochelas as microscleres; color fire red in life; amorphous ... *Merriamium tortugasensis*

No tornotes in the megasclere population ... 40

40. Spicules all under 500 microns in length ... 41

Spicules over 1 mm in length common; spiculation of huge strongyloxeas (many over 1 mm long), styles about 200-250 microns long, plus microscleres consisting of spherasters, chiasters and oxyasters; shape subspherical and tuberculate; color orange ... *Tethya aurantia*

41. Spiculation of oxeas, styles, and strongyles, plus microxeas or immature oxeas; all spicules basically oxeas but with wide variation in form; exterior color lavender, interior color brown; shape amorphous ... *Rhaphisia menzeli*

Spiculation of slightly acanthose, slightly bent styles and strongyles, plus toxas and predominantly palmate isochelas (a few are arcuate); color bright orange; shape encrusting ... *Holoplocamia delaubenfelsi*

42. Monactine megascleres only present, no microscleres ... 43

Monactine megascleres plus microscleres present ... 49

43. Both tylostyles and styles present, with acanthostyles; shape thinly encrusting ... *Eurypon clavatella*

Tylostyles or styles present, but not both ... 44

44. Styles only present ... 45

Tylostyles present, with or without acanthostyles ... 46

45. Shape flabellate to palmate with a special axis; color bright orange-red; spicules styles about 220 x 10 microns in size ... *Homaxinella waltonsmithi*

Shape thickly encrusting to massive and amorphous; color orange-pink; spicules styles 130-350 microns long and 2-5 microns wide ... *Hymeniacidon heliophila*

46. Tylostyles plus acanthostyles present; vase-shape; color black ... *Thalyseurypon vasiformis*

Tylostyles only present ... 47

47. Sponge soft; light yellowish brown; shape encrusting to amorphous ... *Cliona viridis*

Sponge boring or massive cylindrical; consistency corky; color yellow in life; surface papillate ... 48

48. Surface papillae or galleries 1 to 4 mm in diameter and height ... *Cliona celata*

Surface papillae or galleries 4 to 6 mm in diameter and height ... *Cliona caribboea*

49. Plain styles present ... 50

Plain styles absent ... 52

50. Plain styles present with or without subtylostyles ... 51

Plain styles plus tylostyles present, plus spherasters and chiasters as microscleres ... *Halicomites stellata*

51. Plain styles the only megascleres, plus raphides, toxas, and sigmas as microscleres ... *Toxemna tubulata*

Plain styles plus subtylostyles with very faint heads; microscleres palmate anisochelas, toxas and sigmas; shape encrusting; color orange to orange-red ... *Carmia macilenta*

52. Subtylostyles with faint heads, plus acanthostyles, palmate isochelas, and toxas; shape encrusting to lumpy and lamellate; color dull brick red to orange-red ... *Microciona prolifera*

Tylostyles the only megascleres present (often there are large microxeas, some of megasclere size) ... 53

53. Boring sponges; microxeas often approaching megasclere size ... 54

Non-boring sponges; no microxeas present ... 55

54. Spirasters distinctly angulated ... *Cliona vastifica*

Spirasters not distinctly angulated but more or less rod shaped ... 55

55. Boring galleries in shells of molluscs; microxeas mostly 70-120 microns long, spirasters sometimes slightly angulated ... *Cliona truitti*

Substrate of coral or limestone not bored but permeated by a fine network of sponge tissue to a depth of 2-5 mm; color brick red; spirasters straight and rod shaped ..... *Cliona lampa*

56. Only one type of microsclere; spirasters present 57
Sterrasters abundant as armor, plus spirasters; surface divided into polygonal plates ..... *Placospongia carinata*

57. Color reddish brown to orange or bright crimson 58
Color grey or light brown 59

58. Color orange or red-brown; shape encrusting ..... *Spirastrella coccinea*
Color bright crimson; shape massive and amorphous ..... *Spirastrella coccinopsis*

59. Color grey; shape encrusting to amorphous; generally with two types of spirasters, one normal and the other C-shaped ..... *Anthosigmella varians*
Color light yellow-brown to dark suede; shape massive to cake-shaped; consistency woody when dry ..... *Spheciospongia vesparia*

60. Both tetraxons and large oxeas, *i.e.* oxeas over 500 microns in length 61
Tetraxons without oxeas, tetraxons equi-rayed and acanthose near ends, subtylostyles also present and long (up to 2 mm); thin styles but no microscleres *Cyamon rickersi*

61. Tetraxons are calthrops, also there are microxeas, oxyeuasters, tylasters, chiasters, and peculiar tri-sphaeroid streptasters ..... *Unimia trisphaera*
Tetraxons are not calthrops but triaenes 62

62. Only one type of microsclere present 63
More than one type of microsclere present 65

63. Surface with large pits 4-6 mm wide and deep; color yellow to yellow brown; some triaenes of the "Kudu" type; microscleres sigmaspires ..... *Cinachyra alloclada*
Surface without pits; no "Kudu" type triaenes 64

64. Microscleres sigmoid spirasters 11-16 microns chord length; color grey to brown; surface often felted ..... *Craniella crania*
Microscleres sigmoid spirasters 7-11 microns chord length; dry color yellowish-grey ..... *Craniella cinachyra*

65. Microscleres are sterrasters, especially in stony cortex, and oxyeuasters ..... *Geodia gibberosa*
Microscleres are eutylasters and rare oxyeuasters; no sterrasters ..... *Stelletta grubii*

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VIII. ABSTRACT

A survey of the sponge fauna of the Apalachee Bay region of the Florida Gulf Coast was made during 1956-57. Collections were included from the Panama City, Florida, area. Sixty-five species in forty-seven genera were found, including seven hitherto undescribed species: *Callyspongia repens, Coelosphaera fistula, Eurypon clavatella, Halisarca purpura, Holoplocamia delaubenfelsi, Rhaphisia menzeli, and Scypha acanthoxea.* In addition, *Trachygellius cinachyra* de Laubenfels 1936 was transferred to the genus *Craniella.* A detailed key to the sponges of the area is included.

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HORMONAL CONTROL OF THE REFLECTING RETINAL PIGMENT IN THE ISOPOD *LIGIA OLFERSI* BRANDT[1]

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The light-adapted and dark-adapted positions of the retinal pigments involved in photomechanical adaptation of compound eyes to changes in illumination have been described for three species of isopods. Whether retinal pigments of isopods are independent effectors or are under nervous or endocrine control has not been determined.

Peabody (1939) was the first investigator to describe migration of retinal pigments in isopods. She used *Idotea balthica* and *Idotea metallica.* In her paper she described only distal and proximal retinal pigment cells. Kleinholz (1961) stated that the fixative she used might have dissolved the reflecting pigment.

Nagano (1949) described the structure of the eye in the isopod *Ligia exotica* including the positions of the retinal pigments in light-adapted and dark-adapted specimens. Of interest herein is his diagram showing the reflecting pigment proximal to the basement membrane in illuminated specimens and distal to the basement membrane in specimens kept in darkness. The objectives of the present investigation were to determine (1) whether the light-adapted and dark-adapted positions of the reflecting pigment in the eyes of *Ligia olfersi* are the same as in *Ligia exotica* and (2) whether migration of the reflecting pigment in *Ligia olfersi* is under hormonal control as in higher crustaceans.

Materials and Methods

The specimens of *Ligia olfersi* used in this investigation were collected on pilings along the south shore of Lake Pontchartrain in New Orleans, Louisiana. The authors are indebted to Dr. Thomas E. Bowman of the United States National Museum for identifying this species. In the laboratory the *Ligia* were kept in covered aquariums containing damp pieces of paper.

To observe the reflecting pigment, histological sections of the eyes, 10 μ thick, were prepared. After the appropriate experimental treatment the animals were dropped into boiling water for 15-30 seconds to stop rapidly further migration of the pigment. The heads were then removed and fixed in Carnoy's fluid. Bouin's fluid was unsuitable because it dissolved the reflecting pigment. Paraffin sections were then prepared. As a measure of the position of the reflecting pigment, a reflecting pigment index was devised. This index was the ratio of the mean width of the reflecting pigment in both eyes divided by the distance from the center of the spherical lens to the basement membrane. The latter distance is unaffected by light and darkness. Use of this ratio minimized the effect of size differences among the specimens. The distances were measured with the aid of an ocular micrometer and reflected illumination. The reflecting pigment under such illumination appeared silvery-white. The center of the lens rather than the cornea was chosen as one of the fixed points for measurement because the cornea was frequently torn loose in the histological sections. Each unit of the ocular micrometer at the magnification used corresponded to 10.9 μ. Measurements were made of 20 ommatidia, 10 in each eye. The average ratio for both eyes was then calculated and represented the index of that particular specimen.

Tissue extracts were prepared in the usual manner. The concentrations were two-thirds of a sinus gland, *i.e.* one-third of the isopod's complement, per 0.02 ml physiological saline and one-third of the supraesophageal ganglia in the same volume. The dose injected into each isopod was 0.02 ml.

Student's *t* test was used for determination

[1] This investigation was supported in whole by Public Health Service Research Grant B-838 from the National Institute of Neurological Diseases and Blindness.

of the level of significance between means. The 5% level was considered the maximum for a significant difference.

Observations and Results

Normal migration of the reflecting retinal pigment in Ligia olfersi

The object of the first set of experiments was to determine the positions of the reflecting pigment in light-adapted and dark-adapted eyes. Specimens were placed both in a photographic darkroom and in white enameled pans under an incident illumination of 120 ft-c for two hours, at the conclusion of which the isopods were killed.

Inspection of the sectioned eyes revealed that the reflecting pigment always remained distal to the basement membrane (Fig. 1). In dark-adapted eyes this pigment always abutted against the basement membrane, but in about one-half of the light-adapted eyes some of the pigment had migrated a short distance away, about 10 μ, from the basement membrane. Furthermore, measurements of eyes from 15 light-adapted and 11 dark-adapted specimens revealed that the mean width of the reflecting pigment in the light-adapted eyes was 43.9 μ but in the dark-adapted eyes was 74.5 μ. The difference between the means is statistically highly significant ($p<0.001$). The mean distances from the center of the spherical lens to the basement membrane were 167.3 μ and 171.1 μ for light-adapted and dark-adapted eyes respectively. The difference between these means is insignificant statistically. Consequently, the difference between the widths of the reflecting pigment could hardly have been due to size difference alone. The respective reflecting pigment indexes for light-adapted and dark-adapted eyes were 0.262 and 0.435 (Fig. 2A, B). The difference between these means is also highly significant statistically ($p<0.001$). Accord-

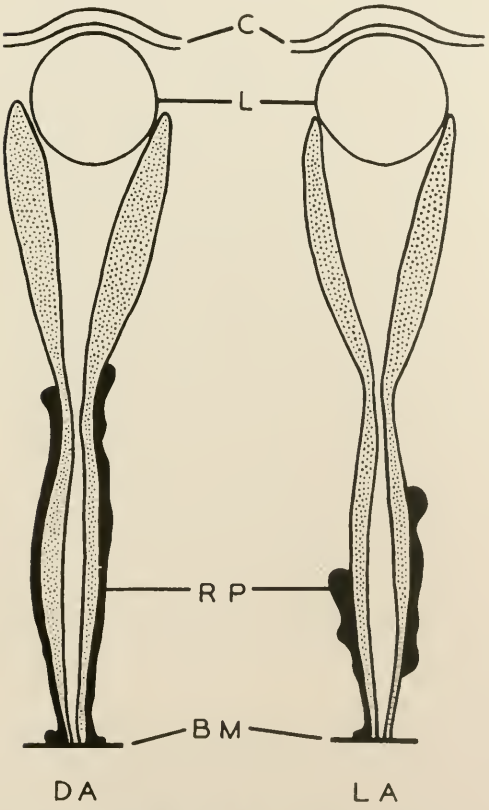

Figure 1. Diagrammatic representation of ommatidia from dark-adapted (DA) and light-adapted (LA) eyes. BM, basement membrane; C, cornea; L, lens; RP, reflecting pigment.

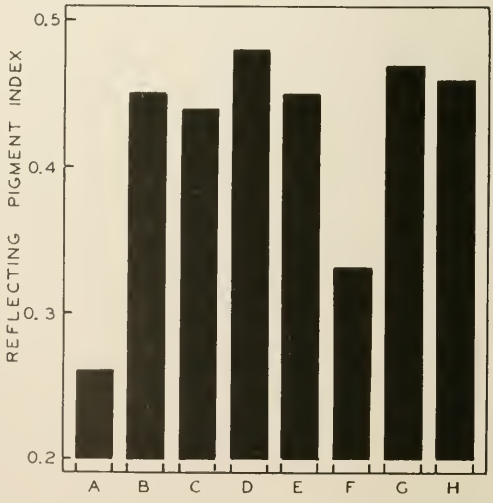

Figure 2. Mean reflecting pigment indexes of (A) light-adapted specimens, (B) dark-adapted specimens, (C) dark-adapted specimens that had received physiological saline, (D) dark-adapted specimens that had received an extract of sinus glands, (E) dark-adapted specimens that had received an extract of supraesophageal ganglia, (F) light-adapted specimens that had received physiological saline, (G) light-adapted specimens that had received an extract of sinus glands, and (H) light-adapted specimens that had received an extract of supraesophageal ganglia.

ing to these reflecting pigment indexes the reflecting pigment is 1.66 times wider in dark-adapted than in light-adapted eyes.

Effect of extracts of sinus glands and supraesophageal ganglia on the reflecting pigment

The object of this experiment was to determine whether migration of the reflecting pigment might be controlled by a principle in the sinus glands or supraesophageal ganglia. Extracts were injected into specimens maintained in the darkroom and into specimens in white containers under an illumination of 120 ft-c. The injections in the darkroom were performed with the aid of a dim, red photographic lamp. Forty-five minutes after injection of the extracts the isopods were sacrificed. The experiments with illuminated specimens were performed three times, with isopods in the darkroom two times. Nine illuminated specimens were injected with extract of supraesophageal ganglia, 10 illuminated isopods with sinus gland extract. Six isopods were injected with each extract in the darkroom. Control specimens received saline alone.

The extracts had no effect on the isopods kept in darkness (Fig. 2C, D, E). However, these extracts caused a dark-adaptational response in the light-adapted specimens (Fig. 2F, G, H). The saline caused a slight but statistically insignificant dark-adaptational response in the light-adapted controls. However, the dark-adaptation shown by the illuminated isopods injected with tissue extracts was equal to that of specimens kept in the darkroom for two hours. These responses were statistically highly significant; $p<0.001$ for the sinus gland extracts and $p<0.01$ for the extracts of supraesophageal ganglia.

Discussion

The description of the positions of the reflecting pigment in light-adapted and dark-adapted specimens of *Ligia olfersi* presented above does not agree with the description of the same phenomenon presented by Nagano (1949) for *Ligia exotica.* He reported that the reflecting pigment lay distal to the basement membrane in darkness and migrated proximal to the basement membrane in light. Herein, however, we noted that this pigment always remained distal to the basement membrane. Elongation of the reflecting pigment in dim light would render this pigment more capable of reflecting light onto the retinula cells, thereby increasing the visual efficiency of the eye in dim light.

Kleinholz (1936) has shown that eyestalk extracts will cause light-adaptation of the reflecting pigment in the prawn *Palaemonetes vulgaris.* Nagano (1947) found the same response in the shrimp *Paratya compressa.* With *Ligia olfersi,* however, the response of the reflecting pigment to extracts of sinus glands and supraesophageal ganglia was dark-adaptation. These observations constitute the first report of (1) a reflecting pigment dark-adapting principle among crustaceans and (2) a retinal pigment activator in isopods. Perhaps further investigation will show that the principle occurs among higher crustaceans as well as in the isopod *Ligia olfersi.*

Summary and Conclusions

1. The reflecting retinal pigment of the isopod *Ligia olfersi* migrates in response to light and darkness.

2. The reflecting pigment always remains distal to the basement membrane. The width of the reflecting pigment is greater in dark-adapted than in light-adapted eyes.

3. The sinus gland and supraesophageal ganglia contain a principle that causes dark-adaptation of the reflecting pigment.

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ABSTRACT

The reflecting retinal pigment of the isopod *Ligia olfersi* migrates in response to light and darkness. The pigment, occupying a wider area in dark-adapted than light-adapted eyes, always remains distal to the basement membrane. Extracts of the sinus glands and supraesophageal ganglia cause a dark-adaptational response of the reflecting pigment. This paper represents the first report of endocrine regulation of a retinal pigment in isopods. The reflecting pigment is involved in photomechanical adaptation of the eye in response to changes in illumination.

HORMONAL AND ENVIRONMENTAL REGULATION OF THE MOLTING CYCLE IN THE CRAYFISH *FAXONELLA CLYPEATA*[1]

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I. Introduction

The molting process, one of the more interesting aspects of crustacean physiology, has been divided by a number of authors (Drach, 1939; Carlisle and Dohrn, 1953; Travis, 1955a; and Passano, 1960b) into four periods: (1) premolt, a period of active preparation for molt, which includes a gradual thinning of the cuticle and storage in the gastroliths or hepatopancreas of the inorganic constituents needed for hardening of the new exoskeleton, (2) molt, the splitting and shedding of the old exoskeleton, (3) postmolt, a period of rapid redeposition of chitin and inorganic salts to produce a new cuticle, and (4) intermolt, a period in which the exoskeleton is hard and calcification is maximal. In the premolt stage of astacurans, specifically, gradual resorption of the inorganic material in the exoskeleton and deposition of calcium salts in the form of gastroliths in the antero-lateral walls of the cardiac stomach occur.

Darby (1938) has stated that operative injury appears to hasten the next molt in the shrimp *Crangon armillatus*. R. Smith (1940) did not find a shortened intermolt period in the crayfish *Procambarus clarki* when an injury, other than eyestalk removal, was inflicted early in intermolt. On the other hand if the subtropical land crab *Gecarcinus lateralis* lacks many limbs, it will molt despite an unfavorable environment (Bliss, 1956). She found that when six to eight limbs were missing, *G. lateralis* molted on completion of limb regeneration; when only one or two limbs were missing, only one of nine crabs molted.

Several investigators have been concerned with the relationship of light and temperature to the molting process. With *G. lateralis,* Bliss (1954) obtained inhibition of premolt regeneration and growth in specimens maintained under constant illumination. She postulated that this effect was mediated through the eyes. Stephens (1955) found that *Orconectes virilis* responded to daily illumination (20 hours) by an increased tendency to molt. Hess (1941) demonstrated that temperature is a factor that influences molting in *Crangon armillatus*. Specimens did not begin molting until the temperature had risen to approximately 29° C and when the temperature fell below this in the afternoon, molting ceased. Light of 75 ft-c had very little if any effect on diurnal molting in this shrimp. The incidence of molting in the lined shore crab *Pachygrapsus crassipes* was also clearly demonstrated to be associated directly with water temperature. Hiatt (1948) found that exuvial frequency was highest during the summer months and relatively low from November to March.

The molting cycle is under hormonal and environmental control. Brown and Cunningham (1939) found that removal of both eyestalks from the crayfish *Orconectes immunis* caused an acceleration of molting. When the contents of eyestalks were implanted into eyestalkless animals, molting activity was postponed. These investigators concluded that eyestalk tissue liberated a humoral substance into the blood which inhibited molting. Abramowitz and Abramowitz (1939, 1940) working with the fiddler crab *Uca pugilator,* R. Smith (1940) with the crayfish *Procambarus clarki,* Kyer (1942) with the crayfish *Orconectes virilis,* and Scudamore (1942) with the crayfish *Orconectes immunis,* also concluded that the eyestalk was a source of molt-inhibiting hormone. In the crayfishes *Orconectes rusticus* and *Orconectes immunis,* Stephens (1951) found that molt inhibition was obtained with implants of supraesophageal ganglia and circumesophageal connectives. Carlisle (1954) using the green crab, *Carcinus maenas,* suggested that molting was partially inhibited during the molting season by some factor emanating from a source other than the eyestalk.

[1] Part of a dissertation submitted in partial fulfillment of the requirements for the Ph.D. degree in Zoology at Tulane University, May, 1962.

Scudamore (1947) suggested that the sinus gland had a retarding effect on gastrolith formation in the crayfish whereas central nervous tissue extracts (supraesophageal ganglia-thoracic ganglia) stimulated gastrolith formation. This observation indicated that central nervous organs outside of the eyestalk were a source of a molt-accelerating substance. In the prawn *Palaemon serratus,* Carlisle (1953) did not find a molt-inhibiting hormone in the eyestalk. Eyestalk ablation led to a significant lengthening of the intermolt period, which suggested that a molt-accelerating hormone was present in the eyestalk. Carlisle and Dohrn (1953) reported that eyestalk extracts of the shrimp *Lysmata seticaudata* contained a molt-accelerating factor.

Gabe (1956) was the first investigator to show that Y-organs, paired, bilateral tissue lying beneath the external adductor muscles of the mandibles, were characteristic features of malacostracans. He suggested that the secretory activity of these glands was correlated with molting. Carlisle (1957) reported that the immediate cause of cessation of molting in the crab *Maia squinado* was degeneration of the Y-organ, which secreted a molt-promoting hormone. Echalier (1959) found that bilateral extirpation of Y-organs caused a definite blockage of growth and of molting in the crab *Carcinus maenas.* Working with the crayfish *Orconectes limosa,* Durand (1960) demonstrated histological changes in the Y-organ. Activity of the Y-organ showed a brief period of activity extending from about three days before molt to four to five days after molt.

Statement of the Problem

The present investigation was undertaken to learn (1) the normal molting cycle of the crayfish *Faxonella clypeata,* (2) whether the molting cycle is influenced by photoperiod, (3) whether temperature is directly associated with incidence of molting, (4) whether loss of limbs shortens the intermolt period, (5) whether a molt-accelerating factor exists in *F. clypeata,* and (6) whether a molt-inhibiting hormone exists in *Faxonella clypeata.*

II. Materials and Methods

The crayfish *Faxonella clypeata* (Hay) is a small crayfish; adults are approximately 15 mm (11.0-19.1 mm) in cephalothorax length. The species inhabits fresh-water ponds, ditches, rivers, and swamps in the Southeastern United States. Ovigerous females retire to burrows. Otherwise members of both sexes are active throughout the year except when the habitat is dry.

The experimental animals were collected with a dip net near Pearl River, Louisiana. The population studied occurred in three shallow pine-land roadside ditches that were exposed to direct sunlight part of each day and contained an abundant plant growth. Two ditches paralleled both sides of Louisiana Highway 41 for approximately 400 yards and a third ditch ran for approximately two miles alongside a logging road that branched off Louisiana Highway 41, thus forming a T-shaped collecting area.

Drought conditions, characterized by complete absence of standing water anywhere in the ditches, and wet conditions, characterized by the presence of standing water throughout the ditches, occurred periodically during the study period. The condition depended on the rainfall (U.S. Weather Bureau climatological data) for the area (Fig. 1). The depth of water in the ditches fluctuated from zero to 34 inches, but an intermediate condition usually existed in which the deeper parts of the ditches were wet and the shallower parts dry. Collections were made only when the ditches contained water. Drought conditions occurred during June, October and November of 1960. Otherwise collections were made at least twice a month.

Black (1958) suggested that a cephalothorax length of 11.5 mm was the lower limit for sexually mature males and females of *F. clypeata.* The data presented herein were obtained from animals with a cephalothorax length of 12.0 mm or longer to eliminate the possibility that animals undergoing pre-maturity molts would influence the determination of molting peaks for the adult population.

Preliminary experimental observations on changes associated with premolt showed that gastrolith formation began within 24 hours after bilateral eyestalk ablation. The appearance of gastroliths indicated that the animals were undergoing premolt and was used in the following experiments as the basis for determining whether premolt had begun. The absence of gastrolith formation was

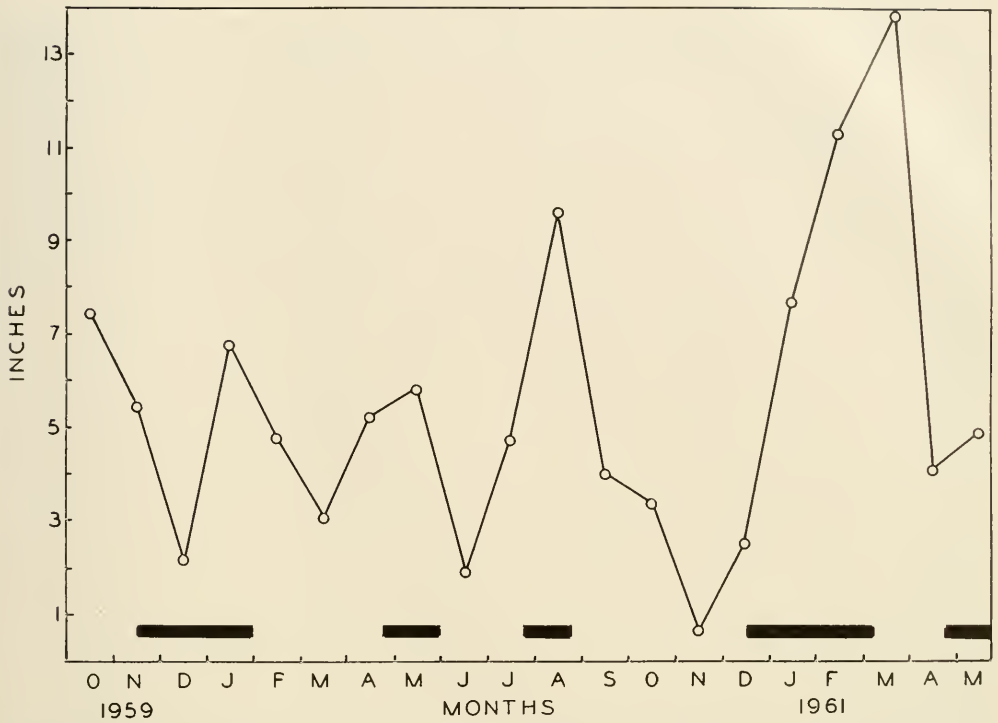

Figure 1. Annual variation in rainfall at Pearl River, Louisiana, expressed as monthly mean number of inches of rain. The solid bars at the base of the figure indicate the period during which 60 per cent or more of the crayfish contained gastroliths.

considered evidence that premolt had been inhibited or had not begun. A soft exoskeleton indicated that the animal had just entered the postmolt phase.

Procedures for statistical analysis of data used in this study were obtained from the book by Snedecor (1956).

III. Experiments and Results

Normal Annual Molt Cycle

To determine the natural molt cycle of *F. clypeata,* collections were made at least twice monthly, except for periods of drought, for 20 months beginning in October, 1959, and ending in May, 1961. A random sample of animals from each collection was dissected to determine the incidence of gastroliths (Table 1). The collections consisted of 9,212 animals and of these, 3,426 were checked for gastroliths.

The collection data (Fig. 2) indicated three major molting periods: fall-winter (November-December-January), spring (April-May), and summer (July-August). Since molting occurred throughout the year, a gastrolith incidence of 60 per cent or above was taken as indication of a molting peak. On only two occasions (September 3 and September 17, 1961) was the percentage of gastroliths below 20. The mean for periods between peaks of molting was 35 per cent with a range of zero to 56 per cent.

Effect of Bilateral Eyestalk Ablation

The precise environmental conditions experienced by the crayfish could not be duplicated in the laboratory. Consequently, measurement of the time between two molts of the same crayfish could not be determined. An experiment was designed to determine the number of days between bilateral eyestalk ablation and the subsequent shedding of the exoskeleton. With the aid of a dissecting microscope, both eyestalks were removed from crayfish by severing the base of the eyestalk with a scalpel. The animals were placed in a dry pan for 10 minutes to allow the blood to coagulate and then they were placed in water. Preliminary experi-

TABLE 1.
Incidence of gastroliths in Faxonella clypeata

Date	With Gastroliths	Without Gastroliths	Percentage With Gastroliths
October 19, 1959	7	18	28
November 7	30	24	56
November 17	23	6	79
November 30	39	39	50
December 22	69	43	62
January 7, 1960	14	2	88
January 21	62	26	70
January 23	36	14	72
February 6	52	63	45
February 17	96	148	39
March 7	32	74	30
March 15	18	29	38
March 19	45	102	31
March 27	17	56	27
April 6	111	100	52
April 24	111	74	60
May 1	101	11	90
May 3	20	8	71
May 13	59	29	67
May 27	15	21	42
July 17	16	9	64
July 23	16	17	48
August 6	78	27	74
August 10	13	3	81
August 16	79	5	94
August 27	48	85	36
September 3	0	5	0
September 17	3	26	10
December 18	13	8	62
December 26	9	4	69
January 1, 1961	28	7	80
January 7	30	2	94
January 21	25	3	89
January 28	18	3	86
February 4	62	11	85
February 18	127	98	56
March 4	104	39	73
March 25	44	144	23
April 16	20	60	25
April 29	50	30	63
May 7	106	77	58

ments showed that animals cooled at 10° C for 15 hours before their eyestalks were removed had a higher percentage of survival than animals that had not been cooled but instead had the stubs electrically cauterized after eyestalk ablation. Forty-six eyestalkless crayfish were kept for 15 days in aquariums containing aerated tap water at room temperatures of 21-24° C. Postmolt crayfish were selected for use in this experiment and were not fed during the course of the observations. The experiment was repeated twice.

In the first five days of the experiment, 83 of 138 animals died before molting and were not included in the results depicted in Fig. 3. By the tenth day all but two molted. They died on the 13th and 15th day, respectively, without having molted. Consequently the percentage of animals molting was 96.4 per cent. The first molt occurred on the fifth day after eyestalk ablation and the last one occurred on the tenth day with a median of 7.9 days for those animals molting.

Influence of Environmental Factors

Light. To determine the effect of daylength on gastrolith production in crayfish, four groups of animals were maintained under different photoperiods from August 9 through October 10, 1960. This experiment was repeated two times, from January 1 to March 18, 1961 and from March 25 to June

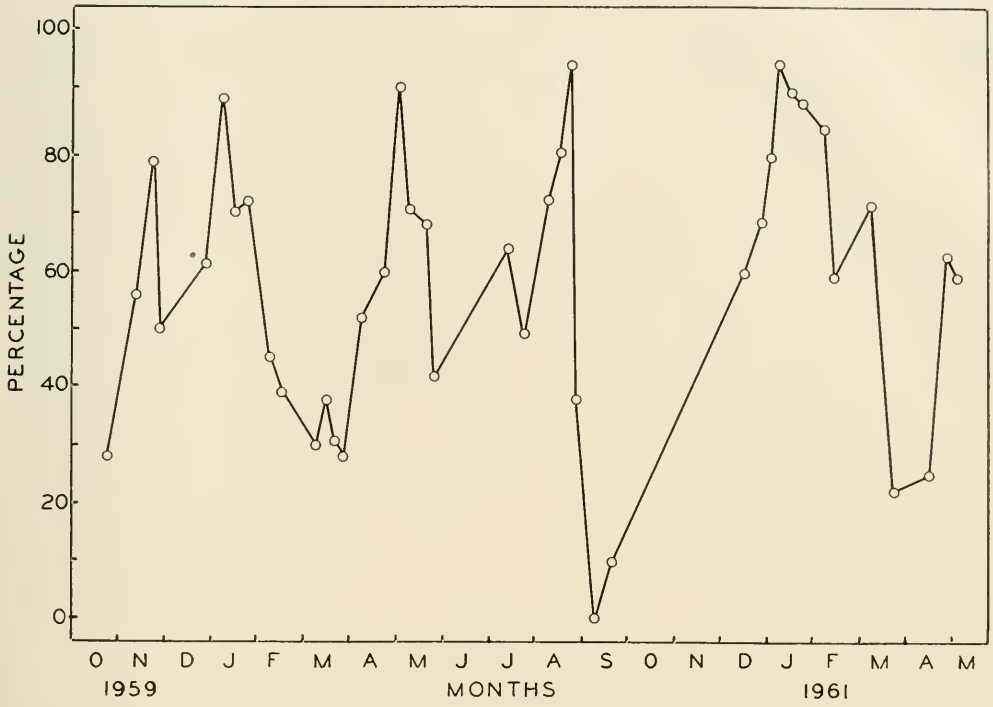

Figure 2. The annual molt cycle of *F. clypeata* expressed as the percentage of animals with gastroliths.

12, 1961. Animals for the first experiment were collected on August 6, 1960; for the second experiment on January 1, 1961; and for the third experiment on March 25, 1961. Males and females were present in each group. The crayfish were maintained in covered rectangular stainless steel tanks, 49 cm long and 37 cm wide, placed side by side in an air-conditioned laboratory. The water was approximately two inches deep and was changed every 15 days. The animals were not fed during the course of the experiment. Illumination was provided in each tank by one frosted 10-watt bulb suspended 20 cm above the water surface. The intensity of illumination at the surface of the water was approximately 40-45 ft-c. Illumination began at 6 A.M. and the duration of light was controlled by automatic time clocks set to provide 6 and 12 hours of illumination daily. Other groups were kept in constant darkness and in constant illumination.

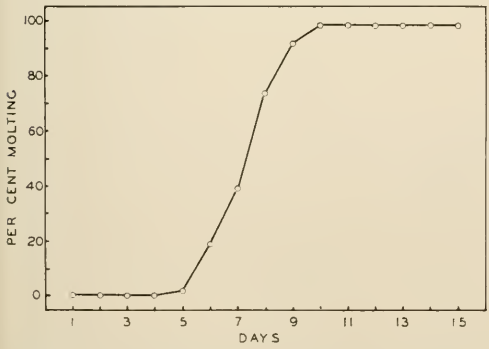

Figure 3. Relationship between the total percentage of crayfish that molted and the number of days after bilateral eyestalk ablation.

All groups started with 90 animals. Group I with mortalities of 33, 61, and 24 per cent in the three experiments respectively was maintained in constant light; Group II with mortalities of 38, 62, and 35 per cent was exposed to 12 hours of illumination; Group III was exposed to six hours of light per day and had mortalities of 44, 68, and 25 per cent; and Group IV with mortalities of 26, 61, and 30 per cent was maintained in constant darkness. A random sample (36, 10, and 24 animals) was selected on the beginning day and a sample (10, 6, and 10 ani-

mals) at intervals of 15 days thereafter for 75 days. The selected animals were removed from each tank and sacrificed to determine the incidence of gastroliths. Exuviae were found when the water was changed but the number of molts per tank was not determined.

The results are summarized in Fig. 4. Group I showed the least tendency toward gastrolith formation. A large peak of gastrolith production was evident in the 15 day sample of the January-March animals and a small peak in the 45 day sample of the March-June animals.

In Group II gastrolith production peaks were noted as follows: 60 day sample in August-October animals, 30 and 75 day samples in January-March animals, and 30 and 60 day samples in March-June animals.

Group III had the greatest tendency toward gastrolith formation. Peaks were as follows: 30 and 75 day samples in August-October animals, 30 and 60 day samples in January-March animals, and a 45 day peak in the March-June animals.

In Group IV gastrolith production peaks were noted as follows: 30 and 60 day samples in the August-October animals, 30 and 60 day samples in the January-March animals, and 30 and 60 day samples in the March-June animals.

The total percentages of gastroliths produced by the animals of each group were: Group I, 41 per cent; Group II, 60 per cent; Group III, 64 per cent; and Group IV, 54 per cent. The differences in behavior between the animals maintained in constant light and Groups II, III, and IV were treated statistically using Student's *t* test. The means of Group I and Group IV were not significantly different whereas Groups II and III

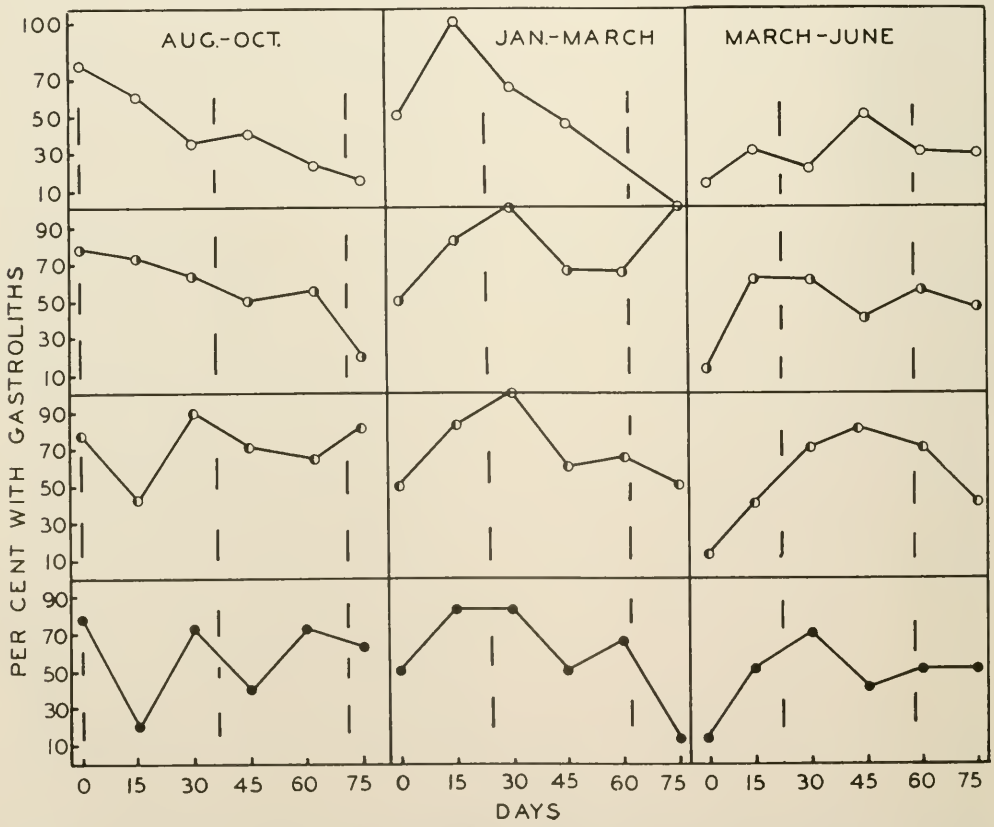

Figure 4. Gastrolith production in *Faxonella* maintained at different daily light periods of 40-45 ft-c.: circles (constant illumination), circles with right half filled (12 hours), circles with left half filled (6 hours), and dots (constant darkness). A probable 40 day intermolt period is indicated by the vertical dashed lines.

were significantly different (p. 0.05 and 0.01 respectively) from Group I.

Temperature. To determine the effects of low temperature on the length of the premolt stage, seven groups of eyestalkless crayfish were placed alternatively between room temperature and a low temperature for varying periods of time. Both eyestalks were removed from postmolt animals as previously described and the eyestalkless crayfish were placed in pans. The pans were white enamel with a bottom diameter 14.5 cm and contained aerated tap water approximately 1.5 inches deep. The room temperature (20-28° C) was maintained by using an air-conditioned laboratory and the low temperature (8-10° C) by placing the animals in a refrigerator. Temperatures were measured by means of maximum-minimum thermometers.

Group I was maintained at room temperature for 24 hours and then placed in the low temperature for 24 hours and then back to room temperature for 24 hours. This alternation of exposure of animals to room temperature and then low temperature was continued until all of the animals had either molted or died. Group II was alternated every 48 hours, Group III every 72 hours, Group IV every 96 hours, Group V every 120 hours, Group VI every 144 hours, and Group VII, serving as the low temperature control, was maintained at 8-10° C for the course of the experiment. Group VIII, serving as the room temperature control, was the batch used above (Fig. 3) to determine the length of time between bilateral eyestalk ablation and shedding of exuviae. The experiment was repeated two times. Animals that died during the course of the experiment were not included in the results.

Table 2 summarizes the results as mean number of days at room temperature before the animals molted. Groups II and IV had the lowest means (7.9 and 7.1 days respectively) and Groups I and VI had the highest means (8.6 and 9.4 days respectively).

The seven experimental groups showed no significant differences; constant low temperatures (8-10° C), however, inhibited the process of premolt to such an extent that the animals did not molt. Analysis of variance by means of the "F" test was used on the results. An F value of 0.90 was obtained which indicated no significant difference among the seven groups.

Influence of Limb Loss on Gastrolith Formation

To determine the effect of limb loss on the incidence of gastroliths, four groups of crayfish with different numbers of limbs missing were kept for a period of 21 days in glass aquariums containing aerated tap water approximately two inches deep. Postmolt crayfish were used and were not fed during the course of the experiment. The aquariums were kept in an air-conditioned laboratory (26-30° C) under identical light conditions.

The chelipeds would undergo autospasy when pressure was exerted on the merus by means of forceps. Walking legs were removed at the base by clipping with fine scissors. The next day 15 animals with the proper number of limbs missing were selected for each group. Group I had one cheliped missing, Group II had two chelipeds missing, Group III had two chelipeds and the first two pairs of walking legs missing, and Group IV having no appendages missing served as the control. The crayfish

Table 2.
Number of days at room temperature required for Faxonella to molt after bilateral eyestalk ablation

Groups	No. of Animals	No. of Animals that Molted	Alternate Period in Low Temp.	Mean No. of Days in Room Temp. Required for Molting
I	60	22	24 hours	8.6
II	60	19	48 hours	7.9
III	60	18	72 hours	8.2
IV	60	18	96 hours	7.1
V	60	18	120 hours	8.3
VI	60	18	144 hours	9.4
VII	30	0	continuous	0.0
VIII	138	53	0 hours	7.9

were sacrificed at the end of the experiment (21 days) and the incidence of gastroliths determined. The experiment was repeated three times and the results are presented in Fig. 5 in which Group I represents 49 animals; Group II, 54; Group III, 57; and Group IV, 54.

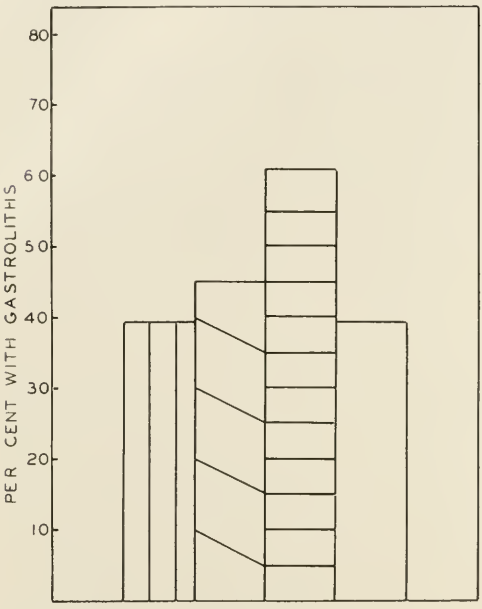

Figure 5. Percentages of crayfish producing gastroliths after appendages were removed. Crayfish with one cheliped removed (vertical line bar), two chelipeds missing (crosshatched bar), two chelipeds and two pairs of walking legs missing (horizontal line bar), and no appendages missing (open bar).

Group I showed a 39 per cent gastrolith incidence, Group II a 45 per cent gastrolith incidence, the control group showed a 39 per cent gastrolith formation, and Group III, having two chelipeds and two pairs of walking legs missing, showed the highest gastrolith incidence, 61 per cent. The number of actual molts that occurred were: Group I, one; Group II, one; Group III, 10; and the control, two.

The above results were treated by a comparison of frequencies using the Chi-square test. Group III, having two chelipeds and two pairs of walking legs missing, showed a statistically significant difference when compared to the control group (p. 0.01). Group II, having two chelipeds missing, did not show a statistically significant difference when compared to the control group (p. 0.30).

In a survey of 753 animals from random collections of groups between molting peaks (Table 3) the following observations were made: 18.98 per cent of the population was either regenerating or would be regenerating limbs, 13.27 per cent had one cheliped missing, 2.39 per cent had two chelipeds missing, 0.93 per cent had two chelipeds and one pair of walking legs missing, 2.12 per cent were regenerating one cheliped, and 0.27 per cent were regenerating two chelipeds.

TABLE 3.
A survey of 753 animals from collections made when the incidence of gastroliths was less than 60 per cent, showing the percentage with missing appendages or those in the process of regenerating limbs

	Number	Percentage
One Cheliped Missing	100	13.27
Two Chelipeds Missing	18	2.39
Two Chelipeds and One Pair of Walking Legs Missing	7	0.93
Regeneration of One Cheliped	16	2.12
Regeneration of Two Chelipeds	2	0.27
Total Number of Animals Missing or Regenerating Limbs	143	18.98

Influence of Endocrine Factors

Molt-accelerating Factor. The following experiments were conducted to determine if a molt-accelerating factor exists either in the eyestalk or in the supraesophageal ganglia and circumesophageal connectives of *F. clypeata.* The experimental animals were selected in a postmolt condition and one eyestalk was removed from each animal 24 hours prior to use in the experiment. Fingerman and Lowe (1957) have found that the chromatophore responses of one-eyed individuals were greater than responses of intact specimens, presumably because the presence of both eyestalks made the crayfish more capable of antagonizing injected chromatophorotropins. The eyestalk is a proven source of molt-inhibiting hormone in the

fiddler crab *Uca pugilator* (Abramowitz and Abramowitz 1939, 1940), in the crayfishes *Procambarus clarkii* (R. Smith, 1940), *Orconectes virilis* (Kyer, 1942), and *Orconectes immunis* (Scudamore, 1942). Preliminary experiments indicated that the eyestalk of *F. clypeata* was a source of a molt-inhibiting hormone and animals with one eyestalk did not molt any sooner than intact animals. The removal of one eyestalk would presumably reduce the titer of molt-inhibiting hormone in the blood and the animal would then be less capable of antagonizing injected molt-accelerating factor.

Eyestalks and supraesophageal ganglia with the circumesophageal connectives attached were removed from only those donor animals having gastroliths. The assumptions were made that those animals having gastroliths were in the premolt condition and if an accelerating factor was present it would be present in greatest titer during this period of the molt cycle.

In the first experiment 40 eyestalks were triturated, suspended in 0.6 ml of van Harreveld's solution (van Harreveld, 1936) buffered to pH 4.8 and 0.02 ml (containing 1.35 eyestalks) of this extract was injected into the third abdominal segment of each of 20 animals. The pH of 4.8 was chosen to determine if an acid solution would activate the molt-accelerating factor. All extracts of eyestalks used in the experiments were centrifuged after trituration to remove the bits of exoskeleton and retinal pigments. Twenty supraesophageal ganglia with the circumesophageal connectives attached were likewise triturated, suspended in 0.5 ml of buffered van Harreveld's solution (pH 4.8) and 0.02 ml (containing 0.8 supraesophageal ganglia with the circumesophageal connectives attached) of this extract was injected into each of 20 animals. The control was composed of 20 animals injected with 0.02 ml each of buffered van Harreveld's solution (pH 4.8).

The animals were placed five to a pan (previously described) under identical light and temperature conditions and were not fed during the course of the experiment. The animals were injected again five and nine days after the original injection. On the 15th day the animals were sacrificed to determine if gastroliths were present. The presence of gastroliths in greater quantity than in the control would indicate that the injections had initiated a premolt condition. The experiment was repeated twice.

The second experiment was conducted in the same manner as described above with the exception that van Harreveld's solution was not buffered and was used at its normal pH of 7.9, this being approximately the pH of the crayfish's blood.

The third experimental procedure was essentially the same as described for the above experiments with the exception that the van Harreveld's solution was buffered to pH 9.6. This pH was chosen to determine if a basic solution would activate the molt-accelerating factor.

The results are presented in Fig. 6. At a pH of 4.8 the injection of the extract of the supraesophageal ganglia with the circumesophageal connectives attached produced a gastrolith incidence of 63 per cent, the eyestalk extract 45 per cent, and the control 37 per cent. In the experiment using a pH of 7.9, the extract of the supraesophageal ganglia with the circumesophageal connectives attached had a 41 per cent gastrolith incidence, the eyestalk extract 39 per cent, and the control 31 per cent. At a pH of 9.6 the supraesophageal ganglia with the circumesophageal connectives attached extract produced a gastrolith incidence of 4 per cent, the eyestalk extract 2 per cent, and the control 5 per cent.

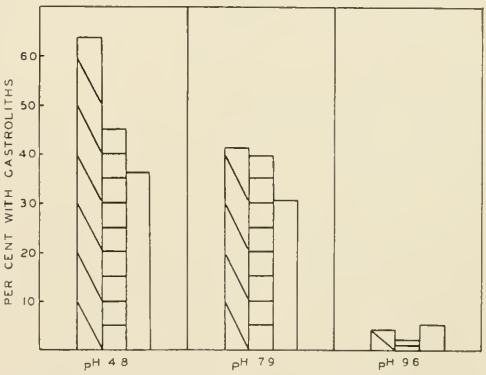

Figure 6. Percentages of crayfish that produced gastroliths after injections of eyestalk extract (horizontal line bar) and supraesophageal ganglia with circumesophageal connectives attached extract (cross-hatched bar). The control group (open bar) was injected with buffered van Harreveld's solution.

The above results were treated statistically by comparison of frequencies using the Chi-square test. Injection of the buffered (pH 4.8) extract of the supraesophageal ganglia with the circumesophageal connectives attached showed a statistically significant difference when compared with the control (p. 0.01). There was no statistically significant difference when the results from injection of eyestalk extract (pH 4.8) were compared with the control. The results from injection of extracts of eyestalks and supraesophageal ganglia with the circumesophageal connectives attached did not show a significant difference compared with the controls at pH values of 7.9 and 9.6 (p. 0.30 and p. 0.20 respectively).

Molt-inhibiting Factor. A molt-inhibiting hormone has been found in the eyestalk of several crustaceans (Abramowitz and Abramowitz, 1939, 1940; R. Smith, 1940; Kyer, 1942; and Scudamore, 1942) and some authors (Stephens, 1951; Carlisle, 1954) have also obtained evidence for an inhibiting factor in the supraesophageal ganglia with the circumesophageal connectives attached. The following experiments were conducted to determine if a molt-inhibiting factor exists in the eyestalk or supraesophageal ganglia with the circumesophageal connectives attached of *F. clypeata*.

Eyestalks and supraesophageal ganglia with the circumesophageal connectives attached were removed from only those donor animals not having gastroliths. The assumptions were made that those animals not having gastroliths were either in the postmolt or intermolt condition and if a molt-inhibiting hormone was present it would be present in greatest titer during these periods of the molt cycle.

Eyestalk extracts were prepared as follows: 80 eyestalks were removed from the crayfish, placed in a mortar and triturated. The triturated eyestalks were suspended in 0.6 ml of the appropriate buffered van Harreveld's solution and centrifuged to remove the bits of exoskeleton and retinal pigments. Three buffers were prepared; 0.1 molar sodium phosphate and 0.05 molar citric acid at pH values of 3.5 and 7.6 and 0.1 molar sodium hydroxide and 0.1 molar boric acid to produce a pH of 9.4. These three pH values were selected to determine: (1) if an acid solution would activate the molt-inhibiting hormone, (2) if this hormone could be detected at approximately the pH of the crayfish's blood, and (3) if a basic solution would activate the molt-inhibiting hormone.

Postmolt specimens of *F. clypeata* were selected because these animals did not contain gastroliths. The success of the experiment would be based on the ability of the injected molt-inhibiting hormone to prevent gastrolith production when the eyestalks are removed. The eyestalks were removed as described above. The animals were placed 20 each into two steel tanks (previously described), kept side by side in an air-conditioned laboratory. Water, aerated by means of an air compressor, was changed every other day. The animals were not fed during the course of the experiment.

The extract at pH 3.5 was taken up in a 1 ml syringe and each of 20 animals was injected in the ventral abdominal region with 0.02 ml (containing 2.70 eyestalks). The control animals were injected with buffered van Harreveld's solution (pH 3.5). On the sixth and tenth day the animals were injected again. The experiment was repeated twice. Extracts at pH 7.6 and pH 9.4 were prepared and injected in the same manner as described above.

The procedure for preparing extracts of the supraesophageal ganglia with the circumesophageal connectives attached was the same as for eyestalks with three exceptions: (1) 40 supraesophageal ganglia with circumesophageal connectives attached were used instead of the 80 eyestalks, (2) the extract was not centrifuged, and (3) each 0.02 ml contained 1.6 supraesophageal ganglia and circumesophageal connectives.

The data presented in Fig. 7 are the percentages of animals that contained gastroliths after 12 days other than those animals that died in the first 48 hours after injection. Animals that died after 48 hours and the live animals remaining at the termination of the experiment were dissected to determine the incidence of gastroliths. The presence of gastroliths in smaller quantity than in the controls would indicate that the injections had prevented a premolt condition. In the experiment with eyestalk extracts the results were: pH 3.5, 79 per cent, control 92 per cent; pH 7.6, 57 per cent, control 98 per cent; and pH 9.4, 70 per cent, control 100

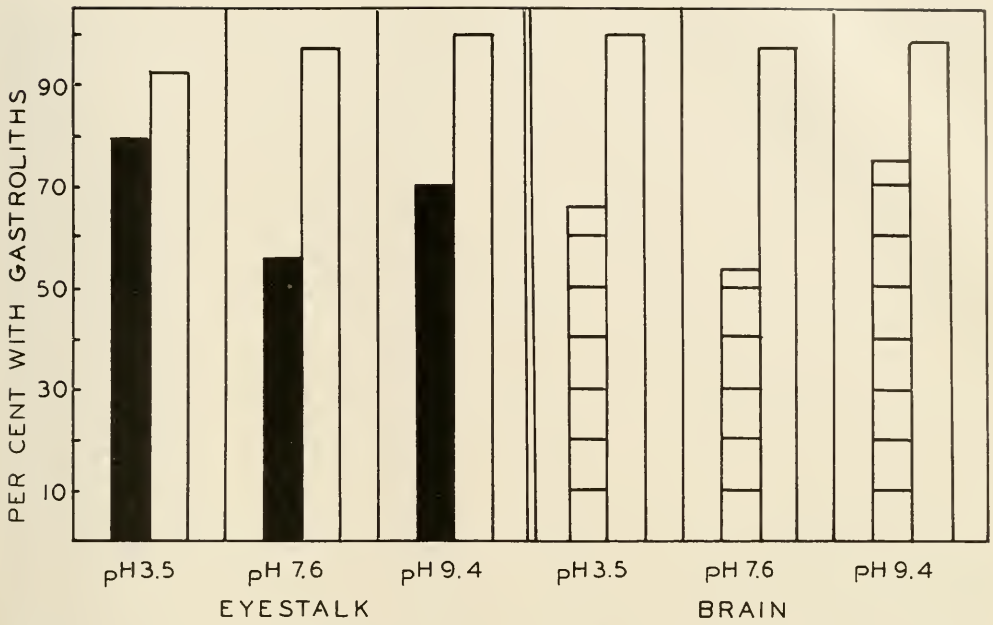

Figure 7. Inhibition of gastrolith formation in *Faxonella* as a response to injected extracts of the eyestalk (black bar) and supraesophageal ganglia with the circumesophageal connectives attached (horizontal line bar). The control group (open bar) was injected with buffered van Harreveld's solution.

per cent. In the experiment with the supraesophageal ganglia and circumesophageal connectives extract the results were: pH 3.5, 69 per cent, control 100 per cent; pH 7.6, 53 per cent, control 97 per cent; and at pH 9.4, 74 per cent, control 98 per cent.

The above results were treated by a comparison of frequencies using the Chi-square test. In the eyestalk and the supraesophageal ganglia with circumesophageal connectives, the inhibiting factor of these extracts at pH values of 3.5, 7.6, and 9.4 showed a statistically significant difference in preventing gastrolith production when compared to the control groups (eyestalk extract, pH 3.5, p. 0.02; remaining extracts p. 0.01).

IV. Discussion

The collection data (Fig. 2), based on per cent of animals with gastroliths, indicated three major molting periods; November-December-January, April-May, and July-August. E. Smith (1953) worked with the growth rate of *F. clypeata* from approximately the same area. She found that maturing females as a group increased significantly in size from February to early June, mid-July to September, and December to January. The male growth pattern was similar to that of the females. Smith's data are substantiated by the gastrolith data in showing that *F. clypeata* undergoes three molts a year.

Rainfall can influence the molting cycle to the extent that animals may be forced to burrow if rainfall is scanty. The animals do not molt in their burrows but wait until they again have ample surface water as was especially noticeable during the winter of 1960-61 when the winter molting peak had shifted approximately 36 days from the period of the previous winter. The amount of rainfall during the months of October and November, 1960, was so small that no surface water collected in ditches, but when the water level again rose after the December rains, the animals began to molt at once after coming out of their burrows (Fig. 1).

R. Smith (1940) found that the intermolt period in the crayfish *Procambarus clarkii* was shorter (average 8.1 days) in eyestalkless animals than in intact ones (28.9 days). Scudamore (1942) determined that the premolt period in the crayfish *Orconectes immunis* was 16.26 days for eyestalkless ani-

mals. Intact animals molted only twice a year (in the spring and summer). The results of R. Smith and Scudamore showed that the intermolt period of eyestalkless animals was shorter than the natural intermolt period. In the crayfish *F. clypeata* the premolt period was 7.9 days after both eyestalks were removed (Fig. 3). The collection data (Fig. 2) indicated that the intermolt period was 60-70 days between the November-December-January molting peak and the April-May molting peak. The intermolt period was 30-40 days between the April-May peak and the July-August peak. Between the July-August peak and the November-December-January peak the intermolt period was 60-70 days. In every case the intermolt period was much longer in intact animals than in eyestalkless ones.

The photoperiod experiment (Fig. 4) showed that exposure of *F. clypeata* to constant light slowed the formation of gastroliths. In reduced photoperiods of 6 and 12 hours the animals had a larger per cent of gastroliths when compared to the animals in constant light. As mentioned above, the normal intermolt period during warm temperatures appeared to be 30-40 days. When a 40 day intermolt period was marked off on Fig. 4, the gastrolith percentage peaks occurred approximately at this interval in groups II, III, and IV. Group I did not follow this pattern but seemed to have a longer intermolt period. This observation was in contrast to the results obtained by Stephens (1955) with a northern group of crayfish. A light period of 20 hours per day during the winter months resulted in an increased molting frequency in *O. virilis*. Stephens postulated that the spring molt in these animals is the result of the transition from darkness or very short daily exposures of light to day-lengths of 12 hours or more when the animals emerge from their burrows in the spring. On the other hand, Bliss (1956) observed that growth in the crab *Gecarcinus lateralis* was inhibited in constant light. Premolt limb regeneration and premolt uptake and retention of water also ceased. Molting did not occur in a constant illumination of 100 ft-c. Suko (1958), working with histological changes of the developing ovaries, found that in the crayfish *Procambarus clarki* the ovaries are influenced by darkness. Secretion of a substance found in the sinus gland and central nervous system that controls ovarian development may have a periodicity. When the quantity of the secretory substance increases to a certain level in the sinus gland, light may be effective in inhibiting the function of the sinus gland.

Constant light may inhibit the production of the molt-acceleration hormone and in reduced light periods of 6 and 12 hours this inhibition would be absent. Once a crayfish begins premolt and then is placed in constant light, the animal will continue premolt but at a slower rate than crayfish at light periods of 6 and 12 hours per day. When the major molting peaks are plotted against day-length (U. S. Weather Bureau data) for the New Orleans area (Fig. 8) molting occurs at the period of short day-lengths and just before and after the longest day-lengths. The April-May molting peak occurs at a day-length of 13 hours and the July-August molting peak at the same length, however at a day-length of 14 hours molting peaks are not found.

In the experiments on temperature, only its role in determining the length of the molting process was considered, not the role of temperature as an activator of molting. The results (Table 2) suggested that once premolt had begun, temperatures of 8-10° C inhibited the actual molting as a result of decreasing the metabolic rate. Mean number of days in room temperature required for molting ranged from 7.1 to 8.6 days for the seven groups. The molting process was inhibited for the time period the crayfish were subjected to low temperatures. No regression in the molting process occurred while the crayfish were chilled. As soon as the animals were placed in room temperatures again, the premolt process progressed until the time the animals were again exposed to an unfavorable temperature.

Passano (1960b) introduced his discussion on temperature effects on crustacean molting with the statement that unlike most environmental variables such as light, temperature can influence both molting itself and molt-control processes. A number of investigators have shown that low temperatures inhibit or lower the incidence of molting and high temperatures increase the incidence (Hess, 1941; Kyer, 1942; Hiatt, 1948; and Passano, 1960a).

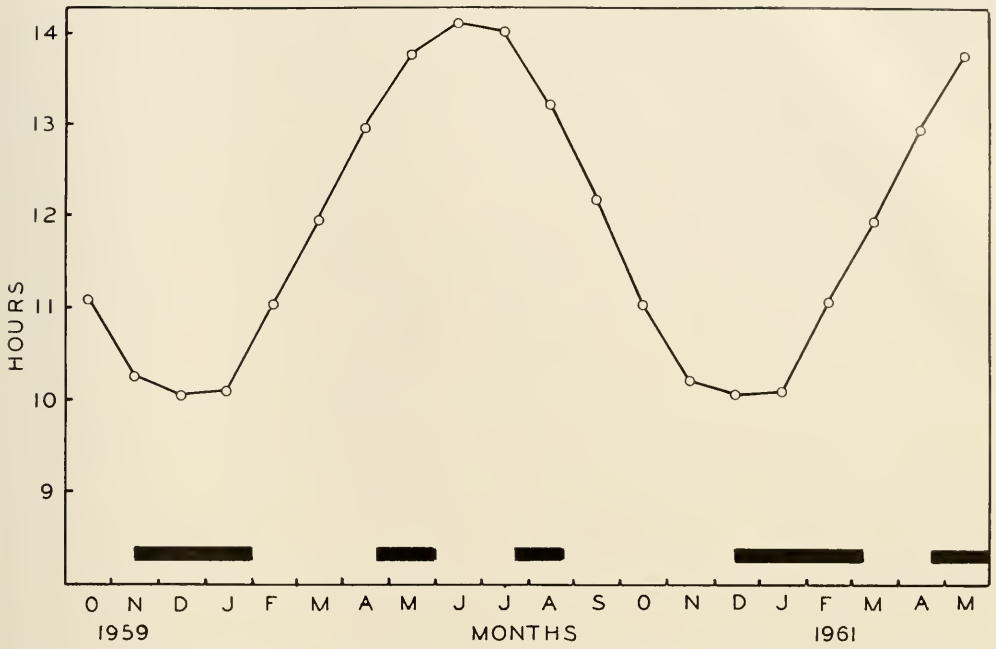

Figure 8. Annual variation in photoperiod at New Orleans, Louisiana, 50 miles southwest of the collection site, expressed as monthly mean number of hours from sunrise to sunset. The solid bars at the base of the figure indicate the period during which 60 per cent or more of the crayfish contained gastroliths.

Diapause in insects is dependent on external factors (photoperiod and temperature) and is followed by molting or hatching. Diapause occurs in any stage of the life cycle except the adult. In the silk worm, *Bombyx mori,* Muroga (1951, cited by Lees, 1955) stated that 40 days chilling is required before it would molt at room temperature. Lees (1955) suggested that from recent experience with the agrotid moth, *Diataraxia oleracea,* and the red spider mite, *Metertetrancyhus ulmi,* temperature should be regarded as a signal stimulus in the same sense as photoperiod. Andrewartha (1943, 1952, cited by Lees, 1955) has shown that if eggs of the grasshopper *Austroiceles cruciata* are chilled at 10° C for 60 days they hatch normally at an incubation of 25° C but if chilled at 6 or 13.5 ° C for the same length of time, fewer eggs hatch when incubated at 25° C. However, normal development occurred when the period was extended beyond the 60 days needed for the 10° C temperature. Williams (1956), working with diapause in the cecropia silk worm, suggested that low temperature served as a catalyst to the brain in restoring the endocrine function.

In the spiny lobster, *Panulirus argus,* Travis (1955a) postulated that molting frequency was a consequence of metabolism. Broekhuysen (1955) found an incubation period of one month was necessary for eggs of the crown crab, *Hymenosoma orbiculare,* at 16.5° C but 38-48 days were required at 12-15° C. A temperature of 10° C blocked premolt in the crab *Sesarma* and when such blockage was removed, premolt proceeded normally (Jyssum and Passano, 1957). Vernberg (1959) showed in the fiddler crabs *Uca pugnax* and *Uca rapax* that temperature affected metabolism. Passano (1960a) hypothesized that a metabolic event was blocked by temperature in the molting of the fiddler crab, *Uca pugnax.*

F. clypeata molted throughout the year and temperatures were never low enough (8-10° C) to block molting completely for any extended period of time. Inasmuch as the U. S. Weather Bureau does not maintain a temperature station at Pearl River, the temperatures recorded (Fig. 9) are from Slidell, Louisiana, eight miles southwest of

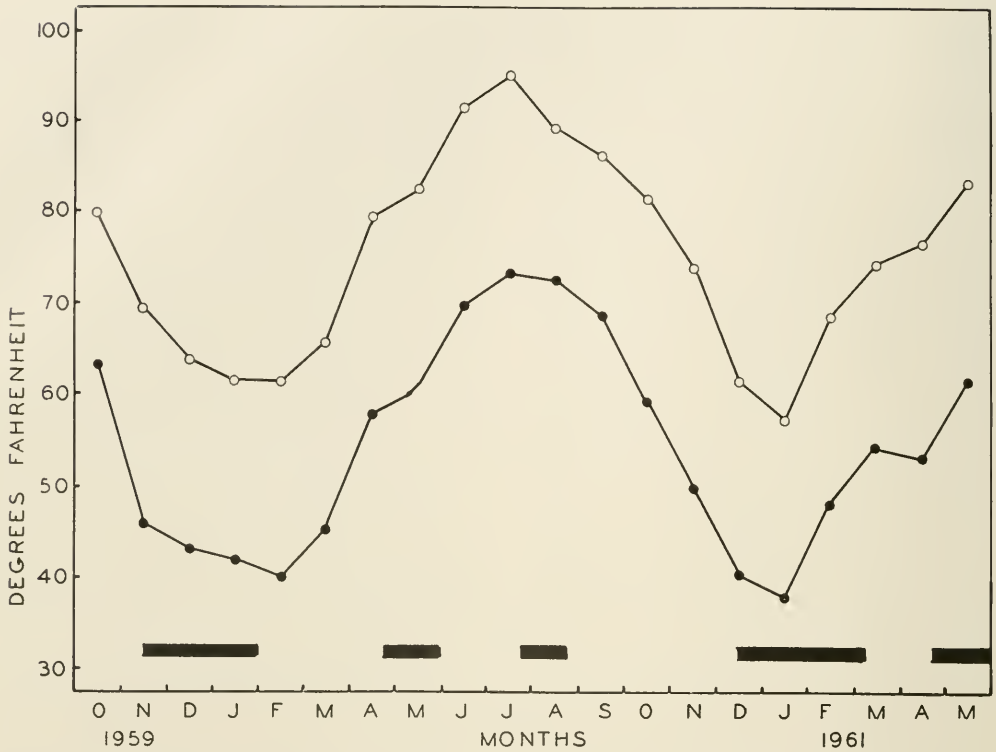

Figure 9. Annual variation in temperature at Slidell, Louisiana, eight miles southwest of collection site, expressed in terms of mean monthly temperatures (circles, high and dots, low). The solid bars at the base of the figure indicate the period during which 60 per cent or more of the crayfish contained gastroliths.

the collection area. Major molting peaks occurred when the temperatures were the lowest for the area and when the temperatures were the highest. The molting periods in both warm and cool temperatures would preclude the conclusion that a chill period such as diapausing insects need is associated with molting in the crayfish *F. clypeata.* The November-December-January molting peak was longer in duration than the peaks occurring in the warmer months presumably because the cold weather (8-10° C) acted as a suppressor. Although a thin film of ice formed over the water surface in January, 1960, and 1961, animals were still present in the water. In insects a cold shock may be necessary before the animal can complete diapause, and thus development, but in the crayfish temperature may act merely to decrease the metabolic rate and not necessarily as an activator of hormonal secretions.

The results (Fig. 5) with *F. clypeata* showed that drastic limb loss was associated with an increase in gastrolith formation. A regeneration stimulus was suggested by Darby (1938) as the reason for the molt-initiating effect of bilateral eyestalk removal. However, later workers have shown that molting was actually initiated by hormones (Brown and Cunningham, 1939; Scudamore, 1942; and Passano, 1953). R. Smith (1940), working with the crayfish *P. clarki,* found that an eyestalk injury was the only type injury that would produce a molt-initiating effect during the early intermolt period. In a sample of five animals, Bliss (1956) produced molting in *G. lateralis* by removing six to eight limbs, but only one out of nine animals molted when she removed one or two limbs. Passano (1960b), however, did not find a molt-inducing stimulus in *Carcinus* on loss of six appendages.

Brown and Cunningham (1939) have shown in the crayfish *Orconectes immunis,* that eyestalk tissue, under nervous control, liberates a hormonal substance into the blood

which inhibits molting. In the crayfish *Cambarus propinquus,* Scudamore (1948) postulated that one reason egg carrying females did not molt was because the presence of the eggs on the pleopods sent an impulse over nerve-reflex pathways that prolonged the molt-inhibiting action of the sinus glands. In *F. clypeata* appendage loss may result in nervous system stimulation which inhibits the sinus gland from releasing the molt-inhibiting hormone, consequently gastroliths may then be formed.

Explanation of activation of the neurosecretory system by loss of appendages may be similar to the thesis used by Fingerman and Fitzpatrick (1956) in which they explained why the fiddler crab *Uca pugilator* exhibited a sexual difference in coloration. In this situation removal of the male's large chela reduced the blood volume to such an extent that the titer of darkening hormone was concentrated and thus produced darkening, however in the female, limb loss did not have as drastic an effect. Appendage loss in *F. clypeata* may have reduced the blood volume to such an extent that the titer of the molt-accelerating hormone was concentrated and thus caused gastrolith formation.

In *F. clypeata* it seems probable that a nervous mechanism is involved in the increased gastrolith formation following drastic loss of limbs. The hormonal mechanism described above requires a serious reduction in blood volume and the loss of two chelipeds and two pairs of walking legs would not reduce the blood volume enough. In *Uca* the large claw was approximately one-third of the body volume. If the production of gastroliths was due to a nervous impulse, then it would seem likely that the loss of two chelipeds did not produce a sufficient nerve stimulus to initiate gastrolith formation, whereas the loss of two chelipeds and two pairs of walking legs did produce a sufficient stimulus.

The loss of appendages may be one of the factors influencing animals to molt between molting peaks. In collection samples from periods between molting peaks, 18.98 per cent of the population contained animals either missing appendages completely or regenerating them (Table 3). Although intact specimens with gastroliths were also found at the same time, limb regeneration may explain why some animals were molting at times other than during the peak periods when the majority of the crayfish molted.

The results from the experiments on the molt-accelerating factors are presented in Fig. 6. In the experiment using van Harreveld's solution buffered to pH 4.8, the results indicated that a gastrolith producing factor existed in the extracts of the supraesophageal ganglia with the circumesophageal connectives attached. Scudamore (1947) suggested the possibility of nervous or secretory factors in or near the central nervous system having a molt-accelerating action. When he injected extracts of central nervous tissue into eyestalkless *O. immunis* and *O. virilis,* stimulation of gastrolith formation and an increase in the rate of oxygen consumption were noted. Carlisle (1953) stated that evidence points to the existence of an eyestalk molt-accelerating hormone in the shrimp *Palaemon serratus.* In 1953, Carlisle and Dohrn published a paper on the shrimp *Lysmata seticaudata* in which they injected intramuscularly an acidified extract of eyestalk tissue and found an accelerated rate of molting.

The results of the injection of extracts of eyestalks and of the supraesophageal ganglia and circumesophageal connectives show that a molt-inhibiting hormone exists in these structures (Fig. 7).

The inhibiting hormone may actually be a series of hormones instead of one hormone. Kyer (1942) suggested that in the crayfish *O. virilis* the inhibiting hormone inhibited an enzyme system involved in the removal from the exoskeleton of calcium and its deposition as gastroliths. Scudamore (1947) has shown that implants of sinus glands into eyestalkless *O. immunis* and *O. virilis* inhibited increase in water content and sinus gland extracts decreased the rate of oxygen consumption after eyestalk ablation. Travis (1951a, 1951b) has shown that during premolt the shrimp *Panulirus argus* took in calcium from its environment, reduced calcium excretion to maintain a normal blood calcium balance, and that the eyestalk played a role in the regulation of phosphate metabolism. Blood proteins of *P. argus* increased prior to molt, declined following molt and reached a subnormal value by the third day. Below normal values remained throughout most of the 14 day postmolt observation

(Travis, 1955b). Durand (1956) stated that there are four cytologically distinct types of neurosecretory cells in the eyestalk and brain of *Orconectes virilis*. The Type 2 neurosecretory cells are the only neurosecretory cells that undergo histologically demonstrable changes in secretory activity in relation to the molting cycle.

Further experiments are necessary before one can make a positive statement that the inhibiting factors originating in the eyestalk and supraesophageal ganglia and the circumesophageal connectives are the same or differ physiologically. Inhibition of gastrolith formation is noted at pH values of 3.5, 7.6, and 9.4, thus showing that the molt-inhibiting hormone can be active over a wide range of pH values. This may indicate that a number of hormones are involved. The possibility also exists that these factors are the same substance but stored in the sinus gland and produced in the supraesophageal ganglia and the circumesophageal connectives. Another explanation could be that there are two different sources for the same hormone, similar to the situation in which the mammalian adrenal cortex produces hormones similar in structure and action to sex hormones, both male and female.

V. Summary

1. The molting cycle of the crayfish *F. clypeata* is defined. While animals can be found with gastroliths throughout the year, three major peaks of molting, November-December-January, April-May, and July-August, occur.

2. *F. clypeata* molts, on the average, 7.9 days after bilateral eyestalk ablation.

3. Exposure of *F. clypeata* to constant light reduces gastrolith production, whereas reduced photoperiods of 6 and 12 hours increase gastrolith production.

4. In eyestalkless crayfish subjected to a temperature of 8-10° C, the molting process is blocked but the process resumes on exposure to temperatures of 20-28° C.

5. Limb loss of at least two chelipeds and two pairs of walking legs causes an increase in gastrolith production.

6. An acidified extract (pH 4.8) of the supraesophageal ganglia with the circumesophageal connectives attached accelerates gastrolith formation when injected intramuscularly into *F. clypeata*.

7. A molt-inhibiting factor occurs in the eyestalks and the supraesophageal ganglia with the circumesophageal connectives attached.

VI. Acknowledgements

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Abstract

The molting cycle of the crayfish *Faxonella clypeata* was defined. Field collections were made at least twice

a month, except during periods of drought, from October 19, 1959, through May 7, 1961. While crayfish contain gastroliths throughout the year in Louisiana, three major molting peaks occur in November - December - January, April - May, and July - August.

The three major molting peaks occur during the warmest and coolest parts of the year. The November-December-January peak is longer in duration than the peaks occurring in warmer months due to the fact that cold (8-10° C) acts as a suppressor. In favorable temperatures the molting process continues until the temperature falls below a value that allows the animal to continue the premolt process.

Constant light reduced gastrolith production, whereas crayfish exposed to photoperiods of 6 and 12 hours per day had a higher incidence of gastroliths than the controls.

Rainfall can influence the molting cycle to the extent that animals may be forced to burrow if rainfall is scant. Animals do not molt in their burrows but wait until they again have ample surface water.

Loss of appendages may be one of the factors stimulating animals to molt during the period between molting peaks. When crayfish in the laboratory lose two chelipeds and two pairs of walking legs, the animals increase gastrolith production in comparison with animals having only one cheliped, two chelipeds, or no appendages missing.

A molt-accelerating factor appears to be present in the supraesophageal ganglia and circumesophageal connectives. An acidified extract (pH 4.8) of the supraesophageal ganglia with the circumesophageal connectives attached is active in accelerating gastrolith formation when injected intramuscularly into *F. clypeata.*

A molt-inhibiting hormone was found in the eyestalks and the supraesophageal ganglia plus the circumesophageal connectives. The experimental results suggest that this inhibiting hormone may in reality be composed of a number of hormones.

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MURICIDAE (GASTROPODA) FROM THE NORTHEAST COAST OF SOUTH AMERICA, WITH DESCRIPTIONS OF FOUR NEW SPECIES

HARVEY R. BULLIS, JR.,

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The U. S. Bureau of Commercial Fisheries has conducted two exploratory trawling cruises of the M/V OREGON along the northeast coast of South America from Trinidad to the Amazon River. This work was carried out during the fall of 1957 and the late summer of 1958: on these cruises 295 shrimp trawling stations were completed at depths ranging from 6 to 400 fathoms.

Prior to this work virtually nothing was known of the biological nature of the area traversed, particularly in depths beyond the 25-fathom contour. Some 50,000 specimens collected on the cruises have greatly increased the study material available from this region. The mollusk population was found to be very rich, and the volume of material from the two trips almost equals the total material collected during the 76 other OREGON exploratory cruises in the tropical and subtropical western north Atlantic.

This paper covers the macromollusca belonging to the Muricidae. The genus *Murex* was represented at 56 localities by 11 species taken in depths ranging from 10 to 275 fathoms (living material down to 200 fathoms). Of the eleven, four are new, four are range-extension records of considerable magnitude, and three have been previously reported from the area. A single species of *Trophon* was found at one locality at the upper edge of the continental slope. One species of *Typhis* was found at two localities in the 20 to 30 fathom range.

The general pattern of depth distribution for the specimens of *Murex* found during these cruises is given in Table 1. Locations of OREGON stations corresponding to the numbers given under each species record are listed in Table 2.

Holotypes and paratypes of new species described herein, as well as material pertaining to the other species discussed are deposited in the United States National Museum. Paratypes have been placed in the following collections; Museum of Comparative Zoology, Academy of Natural Sciences of Philadelphia, American Museum of Natural History, Chicago Natural History Museum, Tulane University, and the Marine Laboratory Museum, University of Miami.

I wish to acknowledge with thanks the courtesies extended to me by Dr. Harald A. Rehder, Curator of Mollusks, United States National Museum, and by Dr. William J. Clench, Curator of Mollusks, Museum of

TABLE 1.

Depth distribution records for the species of Murex collected off the northeast coast of South America. Depths with records of live specimens are denoted as 0; depths with records of dead (empty) shells only are denoted as †.

	depth in fathoms																
	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	101-125	126-150	151-175	176-200	201-225	226-250	251-275	276-300
Murex brevifrons	0	0	0	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Murex messorius	0	0	0	†	–	–	–	–	–	–	–	–	–	–	–	–	–
Murex donmoorei	0	0	0	†	–	–	–	–	–	–	–	–	–	–	–	–	–
Murex springeri	0	0	0	0	0	0	0	†	†	†	–	–	–	–	–	–	–
Murex thompsoni	–	0	0	0	0	–	–	–	–	–	–	–	–	–	–	–	–
Murex pomum	–	0	0	0	0	†	†	–	–	–	–	–	–	–	–	–	–
Murex cellulosus nucens	–	–	†	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Murex consuela	–	–	–	–	†	–	–	–	–	–	–	–	–	–	–	–	–
Murex tryoni	–	–	–	–	–	–	†	†	†	†	†	–	–	–	–	–	–
Murex beaui	–	–	–	–	–	–	–	–	–	0	0	0	0	–	–	–	–
Murex oregonia	–	–	–	–	–	–	–	–	–	0	0	0	0	†	†	†	–

TABLE 2.

Station list and localities of collection of Murex off north eastern South America, 1957 and 1958.

OREGON Station Number	North Latitude	West Longitude	General Area	Depth in Fathoms	Date
1981	10°03′	60°01′	Off eastern Venezuela	200	11/ 3/57
1983	09°53′	59°59′	Off eastern Venezuela	125	11/ 3/57
1984	09°45′	59°45′	Off eastern Venezuela	200	11/ 3/57
1985	09°41′	59°47′	Off eastern Venezuela	150	11/ 3/57
1988	09°24′	59°41′	Off eastern Venezuela	110	11/ 4/57
1989	09°45′	59°45′	Off eastern Venezuela	150	11/ 4/57
2002	07°52′	57°22′	Off British Guiana	60	11/ 6/57
2015	07°38′	54°11′	Off Surinam	75	11/ 8/57
2022	07°15′	53°25′	Off Surinam	115	11/ 9/57
2023	07°15′	53°25′	Off French Guiana	135	11/ 9/57
2038	05°46′	53°00′	Off French Guiana	15	11/11/57
2049	04°02′	50°33′	Off Cabo Orange, Brazil	38	11/13/57
2050	04°04′	50°32′	Off Cabo Orange, Brazil	40	11/13/57
2051	04°05′	50°27′	Off Cabo Orange, Brazil	50	11/13/57
2061	02°31′	48°48′	Off Amazon River	55-60	11/15/57
2063	02°35′	48°14′	Off Amazon River	53	11/15/57
2068	02°35′	47°48′	Off Amazon River	120	11/15/57
2080	02°04′	47°00′	Off Amazon River	125	11/17/57
2084	01°45′	46°46′	Off Amazon River	275	11/18/57
2230	08°33′	58°46′	Off British Guiana	41-44	8/29/58
2232	08°31′	58°37′	Off British Guiana	48-46	8/29/58
2236	08°09′	58°23′	Off British Guiana	23	8/29/58
2254	07°07′	57°08′	Off British Guiana	20-22	9/ 1/58
2255	07°09′	57°06′	Off British Guiana	25	9/ 1/58
2267	06°58′	56°02′	Off Surinam	25	9/ 2/58
2268	06°53′	55°59′	Off Surinam	24	9/ 2/58
2269	06°49′	55°57′	Off Surinam	23	9/ 2/58
2271	06°34′	55°54′	Off Surinam	18	9/ 2/58
2272	06°30′	55°52′	Off Surinam	17	9/ 3/58
2274	06°54′	55°40′	Off Surinam	27	9/ 3/58
2275	06°50′	55°39′	Off Surinam	25	9/ 3/58
2276	06°42′	55°37′	Off Surinam	23	9/ 3/58
2284	06°48′	55°12′	Off Surinam	25	9/ 8/58
2285	07°27′	54°54′	Off Surinam	150	9/ 8/58
2286	07°26′	54°49′	Off Surinam	120	9/ 8/58
2289	07°25′	54°35′	Off Surinam	75-80	9/ 8/58
2290	07°27′	54°27′	Off Surinam	110	9/ 8/58
2291	07°27′	54°27′	Off Surinam	135	9/ 9/58
2292	07°28′	54°21′	Off Surinam	115	9/ 9/58
2293	07°27′	54°15′	Off Surinam	115	9/ 9/58
2294	07°25′	54°08′	Off Surinam	115	9/ 9/58
2295	07°27′	53°47′	Off French Guiana	125	9/ 9/58
2296	06°29′	52°30′	Off French Guiana	120	9/10/58
2303	06°04′	52°35′	Off French Guiana	30	9/11/58
2307	05°57′	52°20′	Off French Guiana	31	9/11/58
2309	05°54′	52°17′	Off French Guiana	34	9/11/58
2321	06°52′	53°18′	Off French Guiana	34	9/14/58
2322	06°50′	53°29′	Off French Guiana	34	9/14/58
2324	06°46′	54°24′	Off Surinam	24	9/15/58
2327	06°26′	54°20′	Off Surinam	17	9/15/58
2328	06°33′	54°23′	Off Surinam	21	9/15/58
2329	06°40′	54°25′	Off Surinam	27	9/15/58
2331	06°55′	55°04′	Off Surinam	30	9/16/58
2333	06°58′	55°03′	Off Surinam	31	9/16/58
2334	06°56′	54°55′	Off Surinam	31	9/17/58
2335	06°50′	55°34′	Off Surinam	28	9/17/58
2337	06°50′	55°23′	Off Surinam	29	9/17/58
2344	08°10′	58°18′	Off British Guiana	35	9/19/58

Comparative Zoology, while referring to the collections in their care. Appreciation is also due to Dr. Rehder for critical review of the manuscript and to Emily H. Vokes for numerous helpful suggestions.

MUREX (MUREX) **DONMOOREI,** sp. nov.

Figures 1 and 2.

Material: Station 2051, 1 dead; 2236, 1 alive; 2254 (type locality, 45 miles north of St. Andrews Point, British Guiana, in 20 to 22 fathoms), 1 alive; 2255, 1 dead; 2268, 1 alive; 2272, 2 alive; 2274, 2 alive; 2275, 2 dead; 2284, 6 alive; 2309, 1 alive; 2321, 2 alive, 2 dead; 2322, 2 dead; 2337, 4 alive.

Holotype: height 50 mm, width without spines 22.5 mm, height of aperture 38 mm. Shell solid, heavily sculptured, with an elongate, spinose siphonal canal. Whorls 7.3, including the protoconch of one and three-quarter whorls. Primary whorl slightly eroded, posteriorly flattened. Spire moderately extended. Suture deep, irregular, made undulous by the axial ridges. Aperture ovate and extending into the siphonal canal as a narrow slit. Palatal lip a thick varix, with six stout spines and intervening raised cords, one of which forms an imbricate scale on the face of the varix. Varix incomplete, hollow, opened on the inner surface, behind which is a row of nine white rounded teeth. A single tooth persists in the upper end of the aperture, corresponding to the intruding varix of the penultimate whorl. Parietal lip slightly expanded, adhering above and erect below. Siphonal canal elongate, slightly more than half the length of the shell, and armed with three rows of spines. There are 4 spines in the first two rows and 3 in the third, all are curved slightly forward, and diminish in size anteriorly. Sculpturing on the body whorl consists of 17 distinct spiral cords that cross four or five axial intervarical ridges to form spirally elongate nodules across the ridges. On the posterior half of the canal are 13 spiral cords crossed with fine growth lines. First 3 post-nuclear whorls without varices and strongly cancellate. The varices start on the fourth whorl and are radially aligned, the lower directly behind and adjoining the upper. Ground color light tan, varices brownish. Each spiral cord marked with a dark brown line. Tip of canal mottled yellow, and surmounted by a dark, reddish-brown spot. Operculum thin, reddish-brown, with strong concentric ridges.

Radula typical, formula $0:1:\frac{5}{1}:1:0$. U.S.N.M. 635146.

Discussion: This species was found from eastern British Guiana to eastern French Guiana. The southernmost record is a shell from off Cape Cassipore. OREGON records show a range of 17 to 50 fathoms, but the optimum depths appear to be between 25 and 35 fathoms.

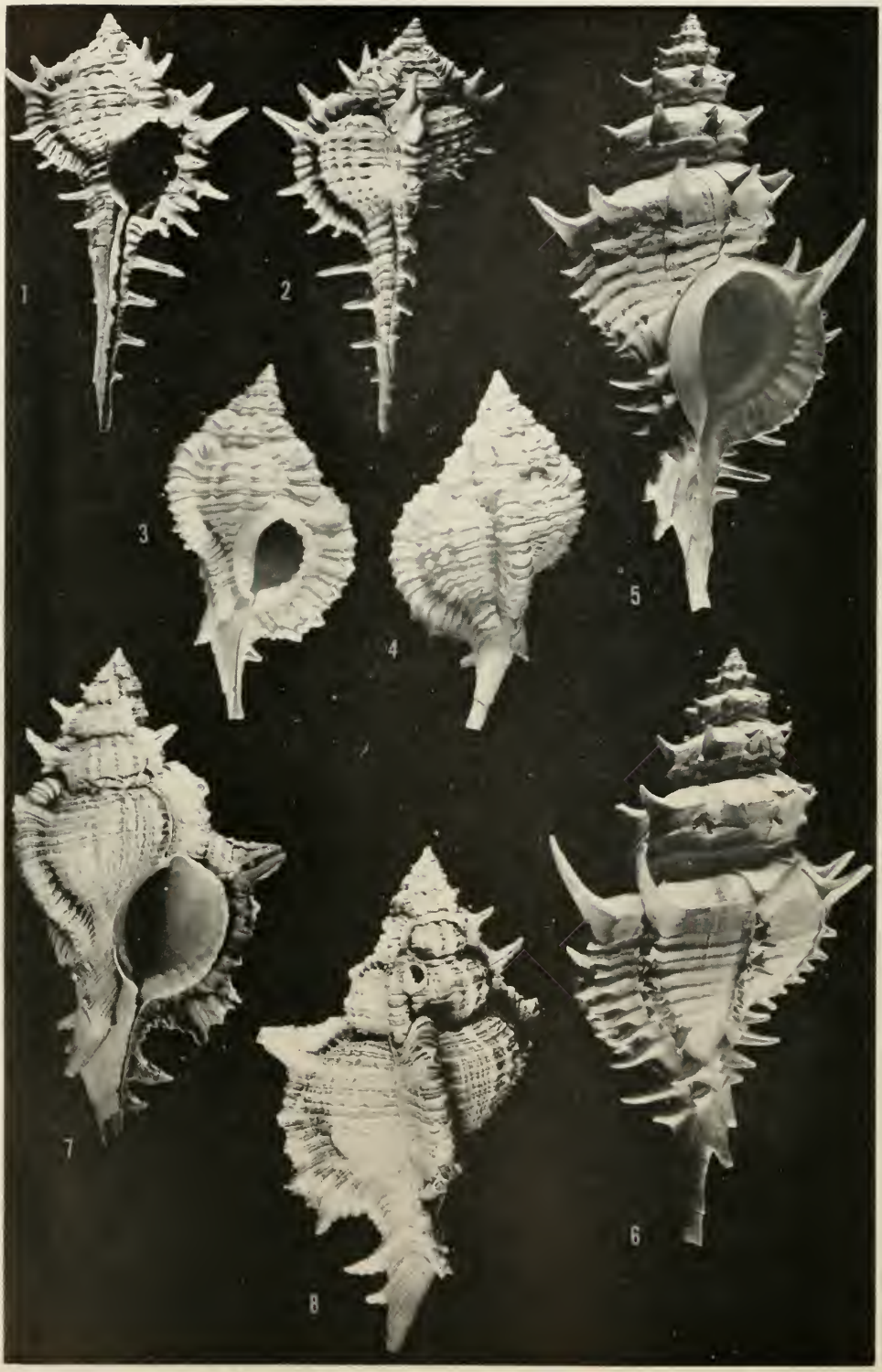
In general shape and sculpturing *M. donmoorei* could be easily confused with *M. cabritii* Bernardi. The gross sculpturing agrees closely in form and structure. Many of the paratypes of *M. donmoorei* show similarly paired pallial crenulations. The dissimilarities are less obvious but are nevertheless striking when series of both species are compared. The new species appears to be a much smaller form, although the protoconch is two to three times as large. The posterior flattening of the apical whorl is combined with a definite low-set suprasutural cord, which differs from the tiny, unsculptured, bulbous protoconch in *M. cabritii.* The anterior canal is proportionately shorter, equal to 50 to 55 percent of the maximum length. In this respect *M. donmoorei* more closely resembles *M. elenensis* Dall (Pacific coast of Central America). In *M. cabritii* the canal varies from 60 to 64 percent of the length. The sharp brown threads that ride the spiral cords are a distinctive color feature. Radular differences are equally distinct. The rachidian in *M. cabritii* is tricuspid, not typical of the genus, whereas there are five strong cusps in *M. donmoorei.*

This species is named for Donald R. Moore, University of Miami Marine Laboratory.

MUREX (MUREX) TRYONI Hidalgo

Records: Station 2230, 3 dead; 2236, 1 dead.

These records extend the observed range from the lower Antilles (Clench and Farfante, 1945) to off French Guiana. The specimen from station 2291, measuring 50 mm, is the largest I have seen.



Figures 1-8. **1** and **2**—*Murex donmoorei*, new species. Holotype. **3** and **4**—*Murex thompsoni*, new species. Holotype. **5** and **6**—*Murex oregonia*, new species. Holotype. **7** and **8**—*Murex springeri*, new species. Holotype.

MUREX (MUREX) MESSORIUS
Sowerby

Records: Station 2230, 3 dead; 2236, 1 dead; 2269, 1 dead; 2272, 1 alive; 2276, 1 dead; 2327, 1 alive; 2328, 6 alive; 2329, 4 alive; 2334, 2 alive.

Recently Vokes (1963) has taken a firm position restricting *M. recurvirostris* (s.l.) to the Pacific coast, resurrecting *M. messorius* Sowerby for the *"recurvirostris"* of the western Atlantic exclusive of Florida, and allying it with *M. sallasi* Rehder and Abbott (Yucatan) and *M. rubidus* Baker (Florida). One must regard this as a clarification of one of the most complex species groups in this region. The present material clearly falls within this group; however, it too displays rather consistent differences from the many described species and subspecific forms. For the present it seems prudent to refer to the entire lot from off the Guianas as *M. messorius* and await the assemblage of material that will afford synoptic treatment.

Specimens in this series reach a length of 65 mm, and the shell is noticeably more solid than in either *M. sallasi* or *M. rubidus*. The aperture is proportionately larger (about 10 percent longer and wider of the total length of the shell) than in *M. rubidus*. The coloration is a mottled brown-tan over cream.

All of the living material collected was taken from catches that contained large amounts of mud and sand, evidence of hard digging by the trawl. Most of the above records came from off the Surinam River along the 30-fathom curve.

MUREX (MUREX) CONSUELAE
Verrill

Record: Station 2063, 1 dead.

Recently Clench (1959) recorded this species (as *M. pulcher* A. Adams) from Salvador (Bahia), Brazil, a range extension of over 2000 miles from Barbados. The present record from the offings of the Amazon River is intermediate.

MUREX (MUREX) **THOMPSONI,**
sp. nov.
Figures 3 and 4.

Material: Station 2061, 12 alive; 2230, 1 dead; 2232, 2 alive; 2269, 1 dead; 2321 (type locality, 75 miles NNE of Pte. Mana, French Guiana, in 34 fathoms), 4 alive, 1 dead; 2322, 7 alive; 2329, 1 dead; 2331, 23 alive; 2333, 4 alive.

Holotype: Height 35.8, width 18.9, height of aperture 22.9 mm. Shell solid and small. Whorls 7.5 including the protoconch. Spire acute, moderately extended. Suture appressed, irregular. Aperture small, oval, porcelaneous white, with a well-developed tooth within the posterior margin. Aperture leading into a narrow slit on the siphonal canal. Outer lip thick, erect, and crenulate. Behind and well-separated from the crenulations are eight elongate denticulations. Parietal lip adherent above, erect below, with four parallel denticulations on the columella. Siphonal canal moderately extended, recurved, and reflected to the right. There are one and one-half bulbous, shiny, unsculptured nuclear whorls. Below these are two and one-half strongly cancellate whorls, followed by the first varical ridge. Each remaining whorl bears three heavy corrugated varices, which are axially aligned and slightly behind the superior varix. Sculpturing consists of alternate strong and light spiral cords that traverse three intervarical ridges to form prominent nodules. These persist over the varices as raised rings which can best be described as *tracheoid*. The lower half of the outer forward margin of each varix supports a low frill. On the last two varices is a short, open spine at the shoulder and another at the base of the canal. On the forward face of the varices there are numerous, fine v-shaped imbrications. Fine growth lines, present over the entire shell, are emphasized by weak ridges of light yellow periostracum. The ground color is light cream. The stronger spirals each have a light, orange-brown thread. Operculum unguiculate, thick reddish-brown, and heavily sculptured with a sub-apical nucleus. U.S.N.M. 635147.

Discussion: The type is somewhat more exotic than the rest of the series at hand but was selected for its size, condition, and apparent maturity. The only larger specimen (44 mm) is more typical but it is badly eroded and heavily encrusted with bryozoans, barnacles, and worm tubes. Generally, the body is more slender and elongate and without spines. The species characteristically shows a tendency to raise a varical web or frill as in *M. cailleti* Petit, but to a lesser

degree. This is present in all specimens down to 22 mm and absent in a series of 23 juveniles ranging from 9.5 to 19.5 mm. Ground coloration varies from whitish to mottled brown. One specimen is marked with two brown bands. The darker lines are present on all living specimens, but they appear to fade quickly on dead shells.

Murex thompsoni may be confused with small specimens of another new species, *M. springeri*. A comparison of their respective characters is given under that species. In the western Atlantic fauna *M. thompsoni* can best be compared with *M. cailleti* (and its subspecies *kugleri* Clench and Farfante), from which it differs in having a smaller aperture, a proportionately heavier varix, and a shorter, stouter siphonal canal. It is also a smaller species and occupies a much shallower depth range. The present series was taken between the Orinoco River and Maraca Island, a range of some 800 miles, in depths of 22 to 60 fathoms. The large series of juveniles came from a depth of 30 fathoms. This species is named after John R. Thompson, colleague at the Bureau of Commercial Fisheries Exploratory Fishing Base, Pascagoula, Mississippi.

MUREX (SIRATUS) BEAUI

Fischer and Bernardi

Records: Station 1981, 4 alive; 1983, 6 alive; 1984, 2 dead; 1985, 7 alive; 1988, 1 alive; 1989, 2 dead; 2080, 1 alive; 2290, 9 alive; 2291, 2 alive; 2292, 1 alive; 2293, 7 alive; 2294, 1 dead; 2296, 4 alive.

These captures extend the known range of *M. beaui* some 1,000 miles, from Guadeloupe Island to northeastern Brazil. The larger specimens (above 100 mm) display an almost complete absence of webbing and are very similar to those caught on grey mud bottom in the north-central Gulf of Mexico. Smaller specimens have webbed varices.

Popular belief is that extreme webbing is directly related to bottom type; numerous observations of this species do not confirm this. More likely the higher degree of varical webbing is atypical. Truly exotic specimens can be found in most of the localities over its range if large series are obtained.

MUREX (SIRATUS) SPRINGERI,

sp. nov.

Figures 7 and 8.

Material: Station 2002, 1 dead; 2015, 2 dead; 2061, 24 alive; 2230, 5 dead; 2232, 1 alive; 2271, 1 alive; 2286, 1 dead; 2289 (type locality, 95 miles NNE of Surinam River entrance in 75 to 80 fathoms), 23 living and dead; 2290, 1 dead; 2322, 23 alive; 2328, 1 alive; 2329, 1 dead; 2333, 7 alive; 2344, 1 dead.

Holotype: Height 70, width 32.7, height of aperture 45 mm. Shell of medium size and solid. Whorls 9.3 including protoconch. Nucleus white and smooth; whorls 2, the first a flattened planorboid coil giving the protoconch a truncate appearance. Spire moderately extended. Suture distinct, the lower whorl applied as a thin fold, below which there is a definite canaliculate depression. Aperture milky white, ovoid, with a slight anal canal bordered on the body wall by a small rounded tooth. Aperture leads into a narrow slit on the siphonal canal. Outer lip extending well beyond the last varix, erect, faintly denticulate within, and moderately crenulated. The crenulations on the outer lip are colored brownish on the inner surface. Parietal lip adherent over most of its length, erect, and lightly denticulate just ahead of where it turns sharply into the siphonal slit. Axial sculpture of three strong varices on each whorl. Each varix supports a single strong spine at the shoulder and two shorter spines on the canal. Shoulder spines imbricate and hollowed, but with a laminated "filling" to the varix edge. This "filling" has the appearance of having been "squeezed out" of the spinal slit. On the spine and along the forward outer edge of the varix there is a substantial low frill which is strongest on the basal portion. Numerous intervarical ridges, diffused and very slight, appear between the last two varices; from three to six on earlier sections. These and the varices are crossed by raised spiral cords, every second to sixth of which is heavier and more darkly colored. This irregular cording produces numerous small, irregularly shaped nodules which are stronger on the spire than on the body whorl. Spirals cross the varices as raised rings or extend onto the frill. Anterior canal moderately extended, rather heavy, recurved, and reflected to the right. Spiral sculpturing

crowded over and between the two spines on the canal but well separated below. Ground color cream, with a brownish band below the shoulder, most prominent on the varices. The heavier spirals are various shades of yellow-brown. The forward face of the siphonal canal is glossy white, but is heavily etched with growth lines. The specimen was collected dead. U.S.N.M. 635148.

Discussion: This species was found quite commonly from eastern British Guiana to Brazil in depths of 18 to 120 fathoms. Most of the deeper records of *M. springeri* are of dead specimens, which tend to be the largest individuals taken.

At less than 30 mm *M. springeri* may be confused with another new species, *M. thompsoni*, due to the latter's occasional tendency to carry a small shoulder spine, and rarely a spine or two on the anterior canal. A reliable way to separate these two is by nuclear characters. The first whorl of the nucleus is bulbous in *M. thompsoni* and posteriorly flattened in *M. springeri*. Neither can be confused with *M. beaui* which at this shell size is very light and fragile, more elaborately frilled, and has a nucleus of one and one-half to three rounded but evenly tapering whorls.

Radular characters also appear to separate these three species. The lateral teeth of all species vary so slightly as to be of little or no diagnostic use. The differences in the characteristics of the rachidian are more of degree than of basic structure. Typically, the muricid rachidian possesses five cusps; the central is usually the longest and heaviest, the outer cusps are somewhat smaller, and the intermediary ones are very small. The basal plate varies relative to the cusps both in shape and size; however the problem of preparing uniform slide mounts makes evaluation difficult. The general specific agreement in cusp formation encouraged me to use this character here.

At a larger size, *M. springeri* resembles closely several specimens of *M. beaui* that I have seen, but in addition to the radular and nuclear characters it differs in being much heavier and having a shorter siphonal canal. Both species are quite variable in shape. As in *M. beaui*, which frequently lacks any sign of spines in the larger forms, several specimens of *M. springeri* lack the shoulder spine. In the large series at hand, all show the spines on the canal. The degree of frilling is also variable, but none of the present material even approaches the magnificent frilling that is seen occasionally in *M. beaui*. This species is named for Stewart Springer of the Bureau of Commercial Fisheries.

MUREX (PHYLLONOTUS) POMUM Gmelin

Records: Station 2050, 2 alive; 2061, 4 alive; 2230, 2 dead; 2267, 2 alive; 2269, 1 dead; 2275, 1 alive; 2284, 11 alive; 2289, 1 dead; 2307, 1 alive; 2322, 5 dead, 1 alive; 2325, 1 alive; 2337, 9 alive.

Although these captures are well within the known geographic range of *M. pomum*, the present records of living specimens range from depths of 25 to 60 fathoms, and for dead shells from 22 to 80 fathoms, well beyond the bathymetric range formerly considered typical. This probably indicates salinity tolerances since the enormous river drainage along this entire coast must certainly lower salinities appreciably out to the vicinity of the 20 fathom curve.

Although the coloring of a few of these specimens resembled that of forms from the shores of United States, many were much lighter, or even whitish, with a light purplish sheen within the aperture.

Assignment of these specimens to *M. pomum* has been done with some doubt following the discussions of Abbott (1958) and Clench (loc. cit.) regarding *M. margaritensis* (s.s.) Abbott. The present material shows the same ambivalence to either name, except for the deep pink coloration of the aperture which is quite striking. However, the brown patch at the posterior siphonal notch is strong. Since my observations of the radulae indicate no discernible differences I have conservatively assigned all of the above specimens to *M. pomum*.

MUREX (CHICOREUS) BREVIFRONS Lamark

Records: Station 2038, 3 alive; 2049, 5 alive; 2050, 2 alive; 2272, 10 alive; 2276, 1 dead; 2303, 2 alive; 2327, 4 alive.

These extend the range of *M. brevifrons* from the Guianas to the offings of the Amazon River. Depths at the collecting sites ranged from 15 to 40 fathoms. Most of the specimens were very elaborately spined and

not at all dissimilar to *Murex argo* Clench and Farfante.

MUREX (POIRIERIA) OREGONIA, sp. nov.

Figures 5 and 6.

Material: Station 1981, 1 alive; 2022, 2 alive; 2023 (type locality, 95 miles north of Pte. Mana, French Guiana, in 135 fathoms), 2 alive; 2084, 1 dead; 2285, 2 alive; 2286, 5 dead; 2291, 1 alive; 2292, 1 alive; 2293, 7 alive; 2294, 5 alive; 2295, 3 alive; 2296, 150 dead and living.

Holotype: Height 90.2, width 37.8 (not including spines); height of aperture 54.9 mm. Shell heavy, elongate, and strongly sculptured. Apex eroded (as are all mature specimens in the series), 8 whorls remaining. Aperture elongate, leading into an extended siphonal canal. Outer lip flared, sharp, somewhat crenulate on the edge and with 13 teeth on the inner margin; the lip supports a strong, upturned, imbricate and hollowed spine at the shoulder. Parietal wall with a raised, erect, shield-like callus. Spire turreted, with a deep, irregular suture. Spiral sculpturing of eight strong cords between the base and shoulder. Axial sculpture of nine varices supporting eight upturned imbricate spines which correspond to the cords, plus the shoulder spine, and a pair of long spines on the base of the siphonal canal. The penultimate whorl has eight varices with the sub-shoulder spines absent, but with nodules at the crossing of the cords and varices, with three cords left exposed. On the rest of the spire only two cords are exposed. The varices cross the shoulder with a step-like overlapping of the succeeding section. Growth lines in the form of undulating wrinkles are most evident on the shoulder. The eight spines below the shoulder on the last varix are imbricately doubled and not directly connected to the margin of the lip. The second varix is similar but a few of the forward spines directly receive involutions of the former lip. This is more so on the third varix and entirely the case on the fourth. Five previous anterior canals are present. Operculum dark reddish-brown, unguiculate, broadly oval with a terminal apex, and strongly sculptured with growth lines. The radula is large; the rachidian has five cusps of about equal length. The middle and outer two cusps are slightly stouter. The laterals are triangulate and hooked. Radular formula is $0:1:\frac{5}{1}:1:0$. U.S.N.M. 635149.

Discussion: This is a striking species that forms a closely related group with *M. pazi* Crosse and *M. nuttingi* Dall, and bears some affinities to *M. atlantis* Clench and Farfante, and *M. carnicolor* Clench and Farfante: the latter to a lesser degree. It differs from all of the above in having paired siphonal spines, and in the length/whorl relationship, being from two and one-quarter to four times greater in size by whorl count. *Murex pazi* and *M. nuttingi* are more similar in shell characteristics than has been previously indicated, with the former showing a great range of sculpturing which may eventually provide a basis for a geographical subspecific distinction. Bahamian and Cuban *M. pazi*, which represent the typical Antillean species, have the intermediary sculpturing between the shoulder and siphonal canal spines greatly reduced. This is exemplified by the figure given by Clench and Farfante (1945, p. 44). Along southern Florida and extending perimetrically around the Gulf of Mexico shelf in the 100 fathom range, *M. pazi* has heavy intermediary sculpturing. *M. nuttingi* might be confused with this group but it can be differentiated by the denticulate inner surface of the pallial lip and the more elongate spines.

The large series of paratypes was collected over a depth range of 105 to 275 fathoms from positions due east of Galeota Point, Trinidad, east of the Amazon River, and at several points between, indicating a continuous range from the equator to 10° North Latitude.

The series from station 2296 (off the Maroni River) included 126 living and 24 dead examples of this species. The specimens range from 40 to 75 mm in height, and provide an excellent series for reviewing some of the juvenile characters. A few of the smallest specimens possess a complete planorboid protoconch of about two whorls that are posteriorly flattened and truncate and bear faint axial riblets on the second whorl. The original protoconch was almost certainly a fragile, deciduous structure of which no trace remains; the protoconch present is a shelly dome, secreted within and

closing off the embryological apical chamber. The coil starts in the form of a "tuck" below the following coil, creating a minute apical pit.

Under 60 mm there are no indications of parietal thickening. The callus is thin and adhering. All spines except the shoulder spines are greatly reduced, and the body appears more attenuate anteriorly. The shells are thin and fragile, marked with four to eight spirals, and have eight to nine varices on the body whorl. They resemble in a general way, *M. atlanticus* except the siphonal spines differ and they do not have a bent canal. The five smallest specimens from station 2296 all have paired siphonal spines. A 44 mm specimen from station 2291 has only a single row, as do six of the entire series at hand. Above 60 mm the spiral cording remains constant at seven or eight lines although some are irregular and faint.

MUREX (FAVARTIA) CELLULOSUS NUCEUS Mörch

Record: Station 2050, 1 dead.

This record extends the southward range of *M. cellulosus nuceus* from St. Thomas, Virgin Islands (Clench and Farfante, 1945), to northern Brazil.

TYPHIS ALATUS Sowerby 1850

Records: Station 2324, 1 alive; 2331, 2 dead.

This species has been reported from the Miocene of the Dominican Republic (type locality), the Chipola formation of Florida, the Gatun formation of Toro Cay, Panama, and from Bowden, Jamaica. Woodring (1928) points out that the entire subgenus *Talityphis* has been considered extinct in the Caribbean region.

A comparison of the present material with the Bowden species and the description and figures of the subspecies *T. a. obesus* Gabb, substantiated Woodring's suspicions as to the validity of *obesus*. The entire group of live and fossil material does not show consistent tangible differences and the present material must be relegated to *T. alatus*.

TROPHON ACTINOPHORUS Dall

Record: Station 2068, 7 alive.

These specimens extend the southward distributional record for this species from south of Barbados to Brazil.

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Abstract

Eleven species of *Murex* were collected off the northeast coast of South America by the M/V OREGON. The material came from 56 localities between Trinidad and the Amazon River in depths ranging from 10 to 275 fathoms. Four of the species are considered new; *M. donmoorei*, *M. thompsoni*, *M. springeri*, and *M. oregonia*. Four species represent first records for the area. Records for live specimens are also given for *Trophon actinophorus* Doll and *Typhis alatus* Sowerby.

CHIRONOMIDAE (DIPTERA) OF LOUISIANA
I. SYSTEMATICS AND IMMATURE STAGES OF SOME LENTIC CHIRONOMIDS OF WEST-CENTRAL LOUISIANA

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Nomenclature

The chironomid fauna of the Southern United States was poorly known until the publication of Henry K. Townes' monumental work on the Nearctic Chironomini (=Tendipedini) in 1945. Since that time several published works have added to the knowledge of a regional chironomid fauna. These are reviewed and the species synonomized as they apply to the present study in the systematic treatment which follows. Since Townes reviewed the synonomy of each species of Chironomini, I shall not duplicate here his lists but rather cite only those relevant contributions since 1945. For those subfamilies and tribes not included in Townes' work, as complete a synonomy as is known to me is given. Citations of the list in my 1955 paper are not given in the synonomies which follow as they were duplicated in my 1957 paper, nor are the species listed by Townes (in Johannsen and Townes, 1952) given since this publication is an abridgment of his 1945 paper.

Nomenclature of the Chironomidae is in an extremely confused state. Notable points of controversy are the Meigen 1800 versus 1803 names and the application of *Tanytarsus* by Townes in a very different sense from customary usage of approximately the previous half-century.

The Meigen names controversy as well as that of *Tanytarsus* are now before the International Commission on Zoological Nomenclature. In the interim, I am following usage that appears to be consistent with the opinion of a majority of dipterologists, as evidenced by publication and personal correspondence.

Two recent publications, Brundin (1956) and Fittkau (1962), have greatly clarified the status and position of many taxa of the Orthocladiinae and Tanypodinae, respectively. Unfortunately, an application of these works to the Nearctic fauna would necessitate a re-examination of most of the types of North American chironomids. To have a solid systematic treatment I am following mostly the taxa of Freeman (1955-1961) that are based largely on adults. I have attempted to indicate position of appropriate species in the Brundin-Fittkau nomenclature.

The following genera and subgenera as used in this paper are compared with those given in Johannsen and Townes (1952), the most inclusive modern work on adult Chironomidae of North America.

Present Usage	*Johannsen and Townes (1952)*
Subfamily Tanypodinae	Pelopiinae
Tanypus	*Pelopia*
Procladius	*Procladius*
(Psilotanypus)	
Procladius (Procladius)	
Coelotanypus	*Coelotanypus*
Pentaneura (Pentaneura)	*Pentaneura* Group C-E
Ablabesmyia	*Pentaneura* Group A
Subfamily Orthocladiinae	Hydrobaeninae
Cricotopus	*Cricotopus*
Nanocladius	*Hydrobaenus (Eukiefferiella)*
Psectrocladius	*Hydrobaenus (Psectrocladius)*
Smittia	*Hydrobaenus (Smittia)*
Subfamily Chironominae	Tendipedinae
Tribe Tanytarsini	Calopsectrini
Tanytarsus (Tanytarsus)	*Calopsectra*
Tanytarsus (Cladotanytarsus)	
Micropsectra	
Tribe Chironomini	Tendipedini
Pseudochironomus	*Pseudochironomus*
Lauterborniella	*Lauterborniella*
Paralauterborniella	*Apedilum*
Polypedilum (Polypedilum)	*Polypedilum (Tripodura)*
	Polypedilum (Polypedilum)
Stenochironomus	*Stenochironomus*
Chironomus (Endochironomus)	*Tanytarsus (Endochironomus)*
Chironomus (Xenochironomus)	*Xenochironomus*
Chironomus (Cryptochironomus)	*Cryptochironomus*
	Harnischia
Chironomus (Chironomus)	*Tendipes (Tendipes)*
	Tendipes (Einfeldia)
Chironomus (Dicrotendipes)	*Tendipes (Limnochironomus)*
Glyptotendipes (Phytotendipes)	*Glyptotendipes (Phytotendipes)*

Scope

Most of the material included in this report was collected while the writer and two of his former graduate students, Burton R. Buckley and Robert F. Tyler, were at Northwestern State College, Natchitoches, Louisiana. Most specimens were collected from Cane River Lake, Chaplain's Lake, and the holding ponds at the United States Fish Hatchery at Natchitoches, Louisiana. Collecting methods included tent and funnel traps (Sublette and Dendy, 1958 (1959)), rearing of larvae and pupae, and light traps. From the latter, specimens included were of species known not to occur exclusively in lotic water.

A small amount of the material presented here was collected while I was engaged in research projects supported by the National Institutes of Health (RG 4594 and 6829) and the Atomic Energy Commission (AT-(40-1)-2596). Most of the results of these researches will appear elsewhere.

Disposition of material is given in parenthesis after the collection data of each species. The following abbreviations are used:

U.S.N.M.—United States National Museum Collection, Washington, D. C.

C.N.C.—Canadian National Collections, Ottawa.

A.N.S.P.—Academy of Natural Sciences, Philadelphia, Pennsylvania.

I.N.H.S.—Illinois National History Survey, Urbana, Illinois.

Duplicate material unless otherwise listed is in my personal collection.

The localities Cane River Lake, Chaplain's Lake, and the United States Fish Hatchery ponds in Natchitoches Parish, Louisiana are abbreviated C.R.L., Ch.L. and U.S.F.H., respectively.

Grateful acknowledgment is made to my wife, Mary Smith Sublette, for assistance in preparation of study material and the manuscript.

Subfamily Tanypodinae

TANYPUS STELLATUS Coquillett

Tanypus stellatus Coquillett, 1902: 89, description of adult.

Protenthes stellatus (Coquillett); Malloch, 1915a: 383, description of pupa and adult.

Tanypus stellatus Coquillett; Johannsen, 1937: 20, description of larva and pupa.

Tanypus stellatus Coquillett; Morrissey, 1950: 90, distribution; description of pupa; phenology.

Pelopia stellata (Coquillett); Johannsen (in Johannsen and Townes), 1952: 10, adult, in key.

Pelopia stellata (Coquillett); Neff, 1955: 5, description of larva, pupa and adult.

Pelopia stellata (Coquillett); Tebo, 1955: 96, ecology.

Pelopia stellata (Coquillett); Paine and Gaufin, 1956: 296, ecology.

Pelopia stellata (Coquillett); Sublette, 1957: 381, ecology; phenology.

Pelopia stellata (Coquillett); Roback, 1957c: 47, 48, description of larva and pupa.

Tanypus stellata (Coquillett); Beck and Beck, 1959: 91, adult.

Pelopia stellata (Coquillett); Davis, 1960: 71 and following pages, ecology.

Pelopia stellata (Coquillett); Judd, 1960: 206, phenology.

Pelopia stellata (Coquillett); Judd, 1961: 95, phenology.

Males: Wing length 2.34-2.43, mean 2.37 mm (3); leg ratio 0.70-0.81, mean 0.76 (3); antennal ratio 2.12-2.30, mean 2.23 (3).

Material examined: Four males, 7-IX-56; 1 female, 11-IX-56; 1 male, 6-VII-57; 1 female, 10-IX-57; 1 male, 17-IX-57; 1 male, 14-X-57; C.R.L. One male, 20-IX-58; U.S.F.H.

TANYPUS new species 1

Description of this new species is given by Sublette (in press in *Proc. U.S. Natl. Mus.*).

Material examined: Specimens from Natchitoches and environs were included in the type series. In addition to these I have examined 2 males, 6-IX-58; U.S.F.H.

TANYPUS new species 2

Protenthes punctipennis (Meigen) Malloch, 1915: 389 (in part), description of pupa and adult, misidentification of *punctipennis* Meigen.

Tanypus punctipennis Meigen; Morrissey, 1950: 90, phenology; misidentification of *punctipennis* Meigen.

Description of this new species is in press in *Proc. U.S. Natl. Mus.*

Larva: Described from exuviae of reared adults. Head pale yellowish, with tips of mandibles, lingula support, and posterior border of the head blackish; head length 0.54 mm. Lingula (Fig. 1) yellowish; superlingulae (Fig. 1) colorless. Labium (Fig. 2) dark brown. Antenna, Figure 3; mandible, Figure 4. Maxillary palpus 2.5 times as long as wide. Body with numerous hairs. Preanal papillae about 5 times as long as wide, slightly curved and colorless; each bears 12 long, colorless bristles; a heavy seta on anterior face. Anal prolegs with about 12 long yellowish claws which are

only slightly curved and which lie parallel to one another.

Pupa: Described from exuviae of reared adults. Pale yellowish except for blackish respiratory organs. Total length 6.98 mm. Length of pupal respiratory organs 0.68 mm. Pupal respiratory organ as shown by Malloch (1915a, Pl. XXVI, figure 13) except that the long hairs shown by him are not visible on my specimens. Abdominal tergites covered with a dense uniform shagreen. Laterally on each tergite are two sets of bristles, the alveoli of which are surrounded by a brownish spot; the anterior pair is anterolateral in position; the posterior set is more medial, in a posterolateral position. Lateral margins of all segments ciliate with a fringe of long colorless bristles which become finer and denser on posterior segments. Anal lobe as figured by Malloch (1915a, Pl. XXVI, figure 4).

The type series was, in part, taken from Cane River Lake and will not be listed here.

Additional material examined: One male, 7-IX-56; 1 female, 11-III-57; 1 male, 23-III-57; 1 male, 15-VII-57; 4 males, 2 females, 6-VIII-57; C.R.L. One female, 28-X-54; 3 males, 3-II-57; 2 males, 4-II-57; 1 male, 9-II-57; Ch.L. Three males, 1 female, 15-II-59; U.S.F.H.

The larva keys to *stellatus* in Johannsen (1937a, page 19), but appears to differ in the form of the paralabial plates (cf. Johannsen 1937a, figure 45, Pl. IV).

The pupa keys in Johannsen (op. cit.) to *punctipennis* Meigen but differs in that the eighth segment has only the fringe of finer bristles.

PROCLADIUS (PROCLADIUS) new species 1

Procladius culiciformis, American authors, nec Linné (Part?).

Procladius culiciformis (Linné); Darby, 1962: 37, 38, 39, 40, 42, 58, 62, 73, 77, 101, 109, 110, 113, 114, 121-128; description of larva, pupa, and adult; ecology; misidentification of *culiciformis* (Linné).

Description of this new species is in press in *Proc. U.S. Natl. Mus.*

Males: Wing length 2.61, 2.70 mm (2); leg ratio 0.74-0.78, mean 0.75 (3); antennal ratio 2.05, 2.36 (2).

Additional material examined: One female, 7-II-56; Ch.L. One male, 21-IV-58; C.R.L. One male, 9-IV-57; 1 male, 16-IV-57; at light, Natchitoches, La.

PROCLADIUS (PSILOTANYPUS) BELLUS (Loew)

Tanypus bellus Loew, 1866; 4, description of adult.

Procladius bellus (Loew); Johannsen, 1905: 128, redescription of adult (after Loew).

[Procladius] bellus [(Loew)]; Johannsen, 1908: 270, subfamily position; genus indeterminate.

Protenthes bellus (Loew); Malloch, 1915a: 388, description of larva, pupa, and adult.

Procladius bellus (Loew); Johannsen, 1937a: 23, redescription of larva and pupa, after Malloch.

Procladius bellus (Loew); Judd, 1949: 8, phenology.

Procladius bellus (Loew); Morrissey, 1950: 90, phenology; ecology.

Procladius bellus (Loew); Johannsen (In Johannsen and Townes), 1952: 10, 11, adult, in key.

Procladius bellus (Loew); Judd, 1953: 813, phenology.

Procladius bellus (Loew); Sublette, 1957: 381, ecology; phenology.

Procladius bellus (Loew); Judd, 1957: 400, phenology.

Procladius bellus (Loew); Roback, 1957c: 48, larva and pupa, in key.

Procladius bellus (Loew): Beck and Beck, 1959: 91, distribution.

Procladius bellus (Loew); Davis, 1960: 71, and following pages, ecology.

Procladius bellus (Loew); Judd, 1961: 96, phenology.

Males: Wing length 1.53-2.04, mean 1.72 mm (4); leg ratio 0.67-0.73, mean 0.74 (4); antennal ratio 1.52-1.84, mean 1.69 (3).

Material examined: Five males, 2-III-57; 1 male, 5 females, 11-III-57; 2 males, 1 female, 12-III-57; 4 males, 16-III-57; 1 male, 28-III-57; 2 males, 5-IV-57; 1 male, 8-IV-57; 1 male, 9-IV-57; 1 female, 12-IV-57; 1 male, 6-V-57; 1 male, 1 female, 14-V-57; 1 male, 15-V-57; 1 male, 16-V-57; 3 males, 1 female, 21-V-57; 1 male, 3-VI-57; at light, Natchitoches, La. One female, 11-VI-57; 1 male, 19-VI-57; 1 male, 1 female, 25-VI-57; 1 male, 18-VII-57; 6 males, 4 females, 13-VIII-57; 1 male, 10-IX-57; 2 males, 3-X-57; 1 male, 7-X-57; 1 male, 14-X-57, 1 male, 19/21-III-58; 1 male, 5-V-58, 1 male, 12-V-58; C.R.L. One female, 20-VIII-58; U.S.F.H.

COELOTANYPUS TRICOLOR (Loew)

Tanypus tricolor Loew, 1861: 309, description of adult.

Procladius tricolor (Loew); Johannsen, 1905: 130, redescription of female, after Loew.

[Coelotanypus] tricolor [(Loew)]; Johannsen, 1908: 270, subfamily position; genus indeterminate.

Coelotanypus tricolor (Loew); Malloch, 1915a: 396, adult.

Coelotanypus tricolor (Loew); Johannsen, 1926: 273, generic position.
Coelotanypus tricolor (Loew); Johannsen, 1934: 348, generic position.
Coelotanypus tricolor (Loew); Johannsen, 1937a: 25, generic position.
Coelotanypus tricolor (Loew); Johannsen (in Johannsen and Townes), 1952: 11, adult in key.
Coelotanypus tricolor (Loew); Sublette, 1957: 382, ecology; phenology.
Coelotanypus tricolor (Loew); Roback, 1957a: 1-2, description of larva.
Coelotanypus tricolor (Loew); Beck and Beck, 1959: 91, distribution of adult.

Female: Wing length 3.24 mm; leg ratio 0.66.

Material examined: One female, 11-IX-56; at light, C.R.L.

COELOTANYPUS SCAPULARIS (Loew)

Tanypus scapularis Loew, 1866: 2, description of adult.
Procladius scapularis (Loew); Johannsen, 1905: 134, description of adult.
Procladius scapularis [(Loew)]; Johannsen, 1908: 270, generic position.
Procladius scapularis (Loew); Malloch, 1915a: 393, description of adults.
Coelotanypus scapularis (Loew); Johannsen, 1934: 348, generic position.
Coelotanypus scapularis (Loew); Johannsen, 1937a: 25, generic position.
Procladius scapularis (Loew); Adams, 1940: 127, distribution.
Coelotanypus scapularis (Loew); Morrissey, 1950: 89, distribution; phenology.
Coelotanypus scapularis (Loew); Johannsen (in Johannsen and Townes), 1952: 12, adult, in key.
Coelotanypus scapularis (Loew); Neff, 1955: 7, adult; ecology.
Coelotanypus scapularis (Loew); Sublette, 1957: 382, ecology; phenology.
Coelotanypus scapularis (Loew); Beck and Beck, 1959: 91, distribution of adult.

Male: Wing length 2.39 mm; leg ratio 0.70; antennal ratio 3.05.

Material examined: One male, 11-IX-56; at light, C.R.L.

COELOTANYPUS CONCINNUS (Coquillett)

Tanypus concinnus Coquillett, 1895: 308, description of adult female.
Procladius concinnus (Coquillett); Johannsen, 1905: 129, redescription of female.
Procladius concinnus (Coquillett); Johannsen, 1908. 270, generic position.
Procladius concinnus (Coquillett); Malloch, 1915a: 394, description of larva, pupa and adult.
Coelotanypus concinnus (Coquillett); Johannsen, 1934: 348, generic position.
Coelotanypus concinnus (Coquillett); Johannsen, 1937a: 25, description of larva and pupa.
Coelotanypus concinnus (Coquillett); Morrissey, 1950: 89, distribution and phenology.
Coelotanypus concinnus (Coquillett); Johannsen (in Johannsen and Townes), 1952: 12, adult, in key.
Coelotanypus concinnus (Coquillett); Roback, 1953: 108, ecology.
Coelotanypus concinnus (Coquillett); Wurtz and Roback, 1955: 199, distribution; ecology.
Coelotanypus concinnus (Coquillett); Paine and Gaufin, 1956: 296, ecology.
Coelotanypus concinnus (Coquillett); Roback, 1957a: 47, ecology.
Coelotanypus concinnus (Coquillett); Sublette, 1957: 382, ecology; phenology.
Coelotanypus concinnus (Coquillett); Beck and Beck, 1959: 91, distribution of adults.
Coelotanypus concinnus (Coquillett); Dendy and Sublette, 1959: 510, adults.
Coelotanypus concinnus (Coquillett); Davis, 1960: 71, ecology.

Male: Wing length 3.27 mm (1); leg ratio 0.76 (1); antennal ratio 2.88 (1).

Females: Wing length 3.06-3.74, mean 3.50 mm (3); leg ratio 0.63-0.70, mean 0.67 (3).

Material examined: One female, 18-V-54; 2 females, 29-IV-57; 1 male, 1 female, 14-V-57; 1 female, 15-V-57; 1 female, 21-V-57; at light, Natchitoches, La.

PENTANEURA (PENTANEURA) PLANENSIS Johannsen

Pentaneura nigropunctata (Staeger); Hauber, 1945: 502, description of adult (genitalia); phenology; misidentification of *nigropunctata* (Staeger).
Pentaneura planensis Johannsen, 1946: 282, 284, description of adult.
Pentaneura planensis Johannsen; Morrissey, 1950: 88, description of pupa and adult; phenology; synonomy.

This species places in the genus *Larsia* Fittkau. For reasons listed earlier, I am using the more inclusive taxon, the genus *Pentaneura*, in a broad sense.

Males: Wing length 1.78-1.80, mean 1.79 mm (4); leg ratio 0.77-0.82, mean 0.79 (4); antennal ratio 1.30-1.60, mean 1.45 (4).

Material examined: One male, 13-VIII-57; 1 male, 9-VII-58; C.R.L. Three males, 12-IX-58; 4 males, 27-IX-58; U.S.F.H.

PENTANEURA (PENTANEURA) PILOSELLA (Loew)

Tanypus pilosellus Loew, 1866: 5, description of adult.
Tanypus pilosellus Loew; Malloch, 1915a: 372, description of ?larva and pupa; adult. The description of the pupa does not agree with my material.
Tanypus pilosellus Loew; Walley, 1928: 583, adult, in key.
?Pentaneura pilosella (Loew); Johannsen, 1937a: 13, redescription of larva and pupa, after Malloch.

Pentaneura piloscella (Loew); Hauber, 1945: 502, description of adult.
Pentaneura pilosellus (Loew); Johannsen, 1946: 282-283, adult, in key; description of adult.
Pentaneura piloscella (Loew); Beck and Beck, 1959: 91, distribution of adults.

This species was placed by Fittkau (1962) in his genus *Labrundinia,* and with this placement I concur. For reasons given earlier I am not employing Fittkau's generic units but rather a broader, more inclusive concept of the genus *Pentaneura.* From Fittkau's exhaustive description of *Labrundinia longipalpis* (Goetghebuer) I suspect that it may be synonymous with *pilosella* (Loew). I hesitate to synonomize it, however, without examining European material. Dr. Fittkau has examined my material and agrees that only a critical comparison of material from Europe and North America can resolve the specific identities.

Males: Wing length 1.26-1.36, mean 1.32 mm (3); leg ratio 0.60-0.80, mean 0.68 (3); antennal ratio 1.21-1.30, mean 1.24 (3).

Material examined: One male, 23-VII-57; 1 male, 13-VIII-57; 3 males, 20-VIII-57; 1 male, 2 females, 27-VIII-57; 1 male, 17-IX-57; 1 male, 7-X-57; 1 male, 19-V-58; 1 male, 10-VI-58; 1 male, 19-VI-58; C.R.L. One male, 12-VIII-58; 1 male, 20-VIII-58; 30 males, 2 females, 28-VIII-58; 5 males, 6-IX-58; 35 males, 12-IX-58; 9 males, 20-IX-58; 16 males, 27-IX-58; 5 males, 4-X-58; 6 males, 15-X-59; U.S.F.H.

ABLABESMYIA AEQUIFASCIATA (Dendy and Sublette), new combination.

Pentaneura (Ablabesmyia) acquifasciata Dendy and Sublette, 1959: 507, description of adult.
Pentaneura (Ablabesmyia) acquifasciata Dendy and Sublette; Darby, 1962: 37, 40, 41, 58, 73, 76, 101, 116-121, description of larva, pupa, and adult; ecology.

Males: Wing length 2.84, 2.84 mm (2); foreleg ratio 0.78, 0.80 (2); antennal ratio 2.16, 2.37 (2); fore tibial band 0.54 (1); basitarsal band 0.40 (1).

Material examined: One male, 28-III-57; 1 male, 5-IV-57; light trap, Natchitoches, La.

ABLABESMYIA PELEENSIS (Walley)

Tanypus peleensis Walley, 1926: 64, description of adult; 1928: 585, 590, adult, in key; notes on adults.
Tanypus peleensis Walley; Adams, 1940: 126, distribution.
Pentaneura peleensis (Walley); Hauber, 1945: 496, 499-500, description of pupa; adult, in key.
Pentaneura peleensis (Walley); Johannsen, 1946: 270, 274, redescription of adult; distribution.
Pentaneura peleensis (Walley); Roback, 1957c: 41, description of larva and pupa.
Pentaneura (Ablabesmyia) peleensis (Walley); Dendy and Sublette, 1959: 508, adult, in key.
Pentaneura (Ablabesmyia) peleensis (Walley); Roback, 1959: 122, added description of adult.

I have compared my material with paratypes from the Canadian National Collection kindly loaned to me by Dr. J. R. Vockeroth.

Males: Wing length 2.48-2.59, mean 2.52 mm (3); leg ratio 0.77-0.84, mean 0.81 mm (3); antennal ratio 2.27-2.50, mean 2.35 (3); fore tibial band 0.47; basitarsal band 0.37.

Material examined: Two males, 18-V-54, Natchitoches, La. One male, 14-X-57; 1 male, 21-IV-58; C.R.L. One male, 12-IX-58; 1 male, 1 female, 27-IX-58; 1 male, 6-XI-58; U.S.F.H.

ABLABESMYIA ILLINOENSIS (Malloch)

Tanypus illinoensis Malloch, 1915a: 376, description of pupa and adult.
Tanypus illinoensis Malloch; Walley, 1925: 272, adult, in key; 1928: 585, 589, adult, in key; distribution.
Pentaneura illinoensis (Malloch); Johannsen, 1937a: 12, redescription of pupa.
Pentaneura illinoensis (Malloch); Miller, 1941: 19, and following pages; ecology.
Pentaneura illinoensis (Malloch); Hauber, 1945: 496, adult, in key.
Pentaneura illinoensis (Malloch); Johannsen, 1946: 270, 273, adult.
Pentaneura illinoensis (Malloch); Johannsen (in Johannsen and Townes), 1952: 6, adult, in key.
Pentaneura illinoensis (Malloch); Paine and Gaufin, 1956: 295, ecology.
Pentaneura illinoensis (Malloch); Judd, 1957: 399, phenology.
Pentaneura illinoensis (Malloch); Beck and Beck, 1959: 90, distribution of adult.
Pentaneura (Ablabesmyia) illinoensis (Malloch); Dendy and Sublette, 1959: 508, adult, in key.
Pentaneura (Ablabesmyia) illinoensis (Malloch); Roback, 1959: 121, redescription of adult.

Males: Wing length 2.48-3.02, mean 2.75 mm (4); foreleg ratio 0.76-0.83, mean 0.79 (4); antennal ratio 2.20-2.52, mean 2.31 (3); fore tibial band 0.54; basitarsal band 0.38.

Material examined: One female, 12-III-57; 2 males, 16-III-57; 1 female, 5-IV-57; 1 male, 8-IV-57; 1 male, 6-V-57; 1 male, 1 female, 21-V-57; 1 female, 16-VII-57; light trap, Natchitoches, La. One male, 2 females, 15-X-58; 1 male, 6-XI-58; U.S.F.H.

ABLABESMYIA **RHAMPHE**

new species

Pentaneura basalis Walley?; Sublette, 1957: 38, larval ecology; misidentification of *basalis* Walley.
?Tanypus sp. A, Malloch, 1915a: 397, larva.

Holotype male: U.S.N.M., No. 66454, collected at light, Natchitoches, Louisiana, 16-VI-57, by James E. Sublette.

Postocular bristles partially in two rows; palpal proportions 20:20:20:42 (paratype); antennal ratio 2.00. Head, including antennal pedicels, and thorax dark brown overlain with a conspicuous greenish pruinescence; prescutellum shining; halteres pale. Wing length 1.89 mm; venarum ratio 0.78; prothorax with about 12 fine lateral bristles; supra-alar bristles 2; prealar bristles, 1 row staggered, becoming 2 rows and dividing around presuctellar area to join dorsolateral bristles where the row then appears doubled back to scutellum. Scutellar bristles about 40, 12 of which are large and erect, forming a straight transverse row, the remainder more or less strewn anteriorly. Dorsolateral bristles in one row. Anterolateral bristles 12.

Fore tarsus not bearded; legs banded; white bands of legs wider than narrow brown bands which they separate; middle brown band of fore tibia about equidistant between basal and apical bands (0.53); fore femur with a broad basal brown band and a narrow apical one; mid and hind femora with only the apical one; remainder of segments on all legs banded as follows: tibia with three bands; basitarsus with one band slightly before center (0.40) and one at apex; Ta_2 to $_4$, each with an apical band only; Ta_5 entirely dark. Tibial spur length and ratio of spur length to diameter of apex of tibia: foreleg, 0.03 mm, 8:8; middle leg, 0.04 mm, 9:8; hind leg, 0.04 mm, 10:9.

Leg proportions:

	F	Ti	Ta_1	2	3	4	5	Leg ratio
Foreleg	42	50	40	28	19	12	7	0.80
Middle leg	45	43	38	20	15	9	8	0.88*
Hind leg	43	55	49	27	19	11	6	0.89

*(paratype)

Wings patterned very much like *aspera* Roback (cf. Roback, 1959, pl. XIV, figure 1) except that the spots are heavier and broader and with those under R_{2+3}, subbasal in M, at end of Cu_1 and in cell Cu_1 confluent at edges.

Tergite I of abdomen largely pale, tergites II-V with an anterior brown transverse fascia, which occupies one-half of segment II becoming wider posteriorly; tergites VI-VII almost entirely dark; genitalia dark.

The basistyle of the genitalia has a conspicuous outward bulge which led me (1957) to identify this species as *basalis?*. At that time I observed that the species differed from *basalis* in some particulars, hence the query. The genitalia most closely resemble *johannseni* Roback but differ significantly in lacking serrations along the accessary blade (Fig. 5, aedeagus in normal position; Fig. 6, everted position).

Allotype: In U. S. National Museum; collected in a tent trap, C.R.L., Natchitoches Parish, Louisiana, 10-VII-57; B. R. Buckley.

Colored as male. Antennal flagellum pale except terminal segment which is dark and bears a terminal bristle; proportions of segments: 13:6:6:6:7:7:6:6:6:8:19 (paratype). Ratio of last segment to remainder, 0.26. Postocular bristles in 2 rows. Palpal proportions 13:15:13:30. Clypeus densely haired with about 45-50 bristles.

Prothorax with 14 fine lateral bristles. Wing length 1.58 mm; supra-alar bristles 2; prealar bristles 25; dorsomedial and dorsolateral bristles as in male; anterolateral bristles 25.

Leg proportions:

	F	Ti	Ta_1	2	3	4	5	Leg ratio
Foreleg	35	42	35	20	15	10	5	0.83
Middle leg	45	40	36	20	13	9	5	0.90
Hind leg	40	50	–	–	–	–	–	0.85*

*(paratype)

Wings heavily haired; wing spots more diffuse and coalesced than in male.

Abdomen fasciate, the bands becoming progressively broader posteriorly. Genitalia with very small lamellae (Fig. 7); 3 spermathecae, large and oval; blackish-brown except at junction of duct (Fig. 8).

The species keys in Roback (1959, p. 120) to couplet 6 where it can be distinguished from *janta* Roback by lacking a brush and from *johannseni* Roback by lacking serrations.

Paratypes: Wing length 1.62-2.12, mean 1.85 mm (9); leg ratio 0.76-0.85, mean 0.81 (4); antennal ratio 1.96-2.35, mean 2.16 (7).

Paratypes examined. One male, 3-IV-57; 1 male, 16-VI-57; 1 male, 25-VI-57; 2 males, 10-VII-57; 1 male, 11-VII-57; 1 male, 18-VII-57; 2 males, 2 females, 23-VII-57; 1

male, 25-VII-57; 1 male, 1 female, 26-VII-57; 1 female, 27-VII-57; 2 females, 29-VII-57; 2 males, 1 female, 30-VII-57; 1 male, 6-VIII-57; 1 male, 1 female, 13-VIII-57; 1 male, 17-IX-57; 1 male, 14-X-57; 1 male, 12-V-58; 1 male, 4-VI-58; C.R.L. One male, 4 females, 28-VI-57; light trap, Natchitoches, La. Five males, 14-VI-62; University of Oklahoma Biological Station, Willis, Oklahoma. In the collections of U.S.N.M., Cornell University, I.N.H.S., A.N.S.P., C.N.C., and Florida State Board of Health.

Larva: Described from exuvia of reared specimen. Head length 0.72 mm; width, 0.44 mm. Mandible (Fig. 9) length 0.12 mm; mandible:head length 0.17. Antenna (Fig. 10) length 0.38 mm; antenna:head length 0.52. Head entirely yellow except for lingula (Fig. 11) and posterior margin of occiput. Maxillary palpus, Figure 12.

Posterior prolegs each with two dark curved hooked claws; with one brown hooked claw; and with 12 slightly curved yellow claws. Preanal papilla about 0.41 as wide as long; each with 7 bristles.

The larva keys in Roback (1957c) to couplet 11 of the key to *Pentaneura* (page 29). It may be distinguished from *peleensis* Walley by having a lower antennal ratio (about 4.5:1) and from *monilis* (Linné) Johannsen (=*americana* Fittkau) by the basal two maxillary palpal segments being subequal.

Pupa: Described from exuvia of reared female and from male pupa with visible genitalia. Pupa length 4.05 mm; exuviae length 3.33 mm. Entirely pale yellow except for dark respiratory organs (Fig. 13) which are 0.36 mm long. Seventh segment with 4 lateral flattened filaments which have the following positions in terms of distance from the anterior margin of the segment: first, 0.41; second, 0.56; third, 0.75; fourth, 0.96. Eighth segment with 5 lateral flattened filaments which have the following positions in terms of distance from the anterior margin: first, 0.28; second, 0.49; third, 0.70; fourth, 0.85; fifth, 1.00. Swim fin, Figure 14.

The pupa keys in Roback (op. cit.) to couplet 11 then no longer fits the key well; it appears to be distinctive in the structure of the respiratory organ (Fig. 13).

Subfamily Orthocladiinae

CRICOTOPUS BICINCTUS (Meigen)

Chironomus bicinctus Meigen, 1818: 41, description of adult.
Cricotopus bicinctus (Meigen); Johannsen, 1905: 256, redescription of adult after van der Wulp, 1874: 132.
Trichocladius sterimanus Kieffer; Potthast, 1915: 243, description of immature stages.
Cricotopus bicinctus (Meigen); Malloch, 1915a: 505, redescription of adult; distribution.
Cricotopus bicinctus (Meigen); Edwards, 1929: 321, redescription of adult; synonomy.
Cricotopus bicinctus (Meigen); Goetghebuer, 1932: 29, 34, description of adult; distribution.
Cricotopus bicinctus (Meigen); Tokunaga, 1936: 16, redescription of adult.
Cricotopus bicinctus (Meigen); Johannsen, 1937a: 54, redescription of immature stages.
Cricotopus bicinctus (Meigen); Miller, 1941: 19, and following pages, ecology.
Trichocladius bicinctus (Meigen); Brundin, 1949: 461, 497, 498, 506, 728; ecology; distribution.
Cricotopus bicinctus (Meigen); Johannsen (in Johannsen and Townes), 1952: 18, adult, in key.
Trichocladius bicinctus (Meigen); Thieneman, 1954: 184, 191, 259, 266, 267, 287, 322, 349, 350, 360, 367, 369, 370, 456, 459, 461, 468, 477, 502, 505, 511, 525, 592; biology.
Cricotopus bicinctus (Meigen); Paine and Gaufin, 1956: 295, ecology.
Cricotopus bicinctus (Meigen); Judd, 1957: 400, phenology.
Cricotopus bicinctus (Meigen); Mundie, 1957: 164, ecology.
Cricotopus bicinctus (Meigen); Roback, 1957c: 71, redescription of larva; distribution.
Cricotopus bicinctus (Meigen); Gaufin, 1958: 205, ecology.
Cricotopus bicinctus (Meigen); Beck and Beck, 1959: 91, distribution of adults.
Cricotopus bicinctus (Meigen); Surber, 1959: 111, ecology.
Cricotopus bicinctus (Meigen); Judd, 1960: 207, phenology.

Males: Wing length 1.58-1.94, mean 1.71 mm (3); leg ratio 0.53-0.63, mean 0.57 (3); antennal ratio 1.41, 1.52 (2).

Material examined: One male, 3-III-57; 3 females, 6-V-57; at light, Natchitoches, La. One male, 21-IV-58; 1 male, 5-V-58; C.R.L.

CRICOTOPUS REMUS new species

Cricotopus tricinctus (Meigen); Sublette, 1957: 384, ecology; phenology; misidentification of *tricinctus* (Meigen). Occurrence of *tricinctus* in the Nearctic region is doubtful.

Holotype male: U.S.N.M. No. 66455; collected in a funnel trap set in 0.5 meters of water, C.R.L., Natchitoches Parish, Louisiana, 21-IV-58, B. R. Buckley.

Antennal pedicel dark brown, antennal flagellum pale brown; postocular bristles in a single staggered row; proportions of palpal

Figures 1-4. Tanypus n. sp. 2. 1. lingula and supralingula of larva; 2. labium; 3. antenna; 4. mandible. **Figures 5-14. Ablabesmyia ramphe new species.** 5. male genitalia, aedaegus in normal position; 6. aedaegus in everted position; 7. female genitalia; 8. spermatheca; 9. mandible of larva; 10. antenna; 11. lingula; 12. maxillary palpus; 13. pupal respiratory organs; 14. swim fin.

segments, 5:7:12:20; antennal ratio 1.27.

Prothorax entirely yellow; broad, almost parallel-sided, with 3 fine lateral bristles. Mesothorax ground color yellow separated by the dark brown vittae; prescutellum yellow; scutellum brown; postnotum dark brown; sternopleuron blackish-brown on venter; halteres pale. Wing length 1.69 mm; prealar bristles 4, 2 large ones posteriorly, 2 small ones anteriorly; dorsomedial and dorsolateral bristles minute, suberect; scutellar bristles 2, large, erect.

Forelegs with femur dark on distal one-third; tibia on basal one-third, and distal one-tenth; tarsi entirely dark. Middle legs with femur dark on distal one-third; tibia, basal one-third; basitarsus largely pale, second tarsal joint dark on distal one-third. Hind legs with femur dark on distal one-third; tibia, basal one-sixth; tarsal joints 1 and 2 pale; 3 dark only on distal one-fourth, 4 and 5 entirely dark. Single long slender spur on fore tibia 1.23 times as long as apical diameter of tibia. Spurs of middle tibia very short, of equal length. Hind leg with inner spur 2.25 times length of outer; tibial comb with 18 bristles; row tapered toward center.

Leg proportions:

	F	Ti	Ta_1	2	3	4	5	Leg ratio
Foreleg	77	100	50	30	20	13	10	0.50
Middle leg	76	80	35	20	15	10	10	0.44
Hind leg	80	92	47	25	20	11	11	0.51

Wings: C slightly produced; R_{4+5} terminates proximal to M; f-Cu distal to r-m; An reaches middle of Cu_2.

Abdomen illustrated in Figure 15.

Genitalia illustrated in Figure 16. The broad spatulate dististyle is distinctive among American *Cricotopus*.

Allotype: In U. S. National Museum. Collected C.R.L., 4-VI-58, B. R. Buckley.

Antennal proportions, 11:7:6:6:17. Ratio of terminal segment to remainder, 0.71. Palpal proportions, 8:12:15:26. Wing length 1.33 mm.

Leg proportions:

	F	Ti	Ta_1	2	3	4	5	Leg ratio
Foreleg	55	70	30	–	–	–	–	0.43
Middle leg	60	55	29	12	10	7	9	0.53
Hind leg	55	65	32	15	14	7	9	0.50

Abdomen similar to male except for sexual differences. Color pattern less intense than male so that dark bands are incomplete on all segments leaving a pale fascia anterior and posterior to each main dark fascia; entire abdomen appearing thus vittate. Spermatheca (Fig. 17); genitalia (Fig. 18).

Paratypes: Wing length 1.46-1.58, mean 1.54 mm (3); foreleg ratio 0.48-0.53, mean 0.51 (3); middle leg ratio 0.39-0.41, mean 0.40 (3); hind leg ratio 0.50-0.52, mean 0.51 (3); antennal ratio 1.20-1.33, mean 1.28 (3).

Paratypes examined: One female, 2-II-57; 1 female, 7-II-57; 2 females, 12-IV-57; 1 female, 16-IV-57; 2 males, 2 females, 29-IV-57; 4 females, 6-V-57; 1 male, 2 females, 21-V-57; 1 male, 3-VI-57; 4 males, 6 females, 14-IV-58; 12 males, 27 females, 21-IV-58; 1 male, 5 females, 5-V-58; 1 male, 3 females, 30-IV-58; at light, Natchitoches, La. In the collections of U.S.N.M., C.N.C., A.N.S.P., I.N.H.S., Cornell University and the Florida State Board of Health.

This species keys in Johannsen (in Johannsen and Townes, 1952) to *trifasciatus* (Panzer) or *tricinctus* (Meigen) depending upon the degree to which the femora are infuscate. Neither of these Palearctic species has been adequately described and separation of the species has been entirely on color characteristics (cf. Edwards, 1929, page 319). Edwards (op. cit.) describes both species as having abdominal segments 1, 4 and 7 mostly yellow; only the posterior margin of *remus* is yellow. The species *tricinctus* is described as having tergites, 2, 3, and 5 entirely black, while *trifasciatus* has 2, 3, and 5 narrowly yellow at base. In *remus* new species 2 and 5 are narrowly yellow but 3 is entirely dark.

Larva: Described from exuvia of paratype male. Head, yellowish-brown; only occiput, labial plate, tips of mandibles and premandibles darker brown; head length 0.53 mm. Labial plate (Fig. 19) and mandible (Fig. 20) very similar to that figured by Johannsen (1937) for *Cricotopus trifaciatus* (Panzer). Antenna (Fig. 21) 0.08 mm long. Mandible 0.16 mm long. In addition to the bristles shown posterior to the labial plate, the venter of the head bears two pairs of closely spaced bristles; one pair lateral to the last tooth of the labial plate and about one-third the width of the plate from the last tooth; the other pair almost at the middle of the head near the lateral margin. In

each set the two bristle alveoli are contiguous. Venter of labrum and epipharyngeal area of typical pattern (cf. Fig. 37 for terminology which follows): near the anterior margin are two strong bristles; seta III, flanked on either side by shorter bristles; posterior to seta III and slightly medial are two strong bifurcate bristles, seta II; lateral to these on each side is a dense clump of 10 to 12 moderately strong bristles, the chaetae. The pecten epipharyngis is formed from three large, triangular, blunt teeth; below these on each side are three long slender teeth, the chaetulae basales. Premandible (torma) bifurcate, yellowish-brown at tips.

The body bears characteristic hair pencils (Johannsen, 1937a, Pl. XV, figure 184). The preanal papillae are about as long as broad, each is blackish-brown on posterior face; on the anterior surface is a fine, pale bristle; each papilla bears six long yellowish-brown terminal bristles. Posterior prolegs with 14-16 slender, gently curved hooks.

Pupa: Described from exuvia of paratype male. Exuvia length 4.13 mm; pale yellowish, slightly darker on lateral margin of last three segments. Respiratory organs (Fig. 22) gradually tapering, 0.24 mm long, without spinules, slightly darker than remainder of integument. Anterior to respiratory organs are three bristles, two anterior large ones and a much smaller posterior one. Dorsum of thorax strongly papillose. Abdominal chaetotaxy very similar to other species of *Cricotopus*. Tergites III to VI with a more or less continuous field of coarse shagreen; intertergal membrane between III and IV, IV and V, and V and VI, with fine shagreen in multiple rows. Tergites VII and VIII not shagreened. Anal lobes with three short, heavy, almost straight bristles. Posterolateral margins of sternites IV-VII with a patch of spinules; sternites IV-VIII with sparse fine shagreen which becomes progressively denser towards posterior segments so that sternites VII and VIII are almost completely shagreened.

The larva keys in Roback (1957c, pages 68, 69) to couplet 8, where it cannot be distinguished from *C. sylvestris, trifasciatus*, or *tricinctus* because of inadequate descriptions.

The pupa keys to couplet 11 (loc. cit., page 70) where, as in the larval stage, it cannot be distinguished from *C. trifasciatus, sylvestris*, or *tricinctus* due to inadequacies of descriptions of those species.

CRICOTOPUS LEBETIS new species

Cricotopus tricinctus (Meigen), American authors, in part.

Holotype male: U.S.N.M., No. 66456. Collected at U. S. Fish Hatchery, Natchitoches, Louisiana, 29-X-58, Robert F. Tyler.

Head, thoracic vittae, sternopleuron, scutellum, postnotum and abdominal tergites II, III, V, VI and VIII blackish-brown; pronotum, narrow mesothoracic ground color and abdominal tergites I, IV and VII yellowish. Antennae and mouth parts blackish. Halteres pale. Coxa of foreleg pale, that of middle and hind leg black; trochanters of all legs yellowish; all femora dark brown becoming still darker apically; fore tibia dark brown basally and apically, paler brown in the middle; middle and hind tibiae darkened apically and basally, infuscate white in the middle; fore tarsi entirely dark; middle tarsi paler brown; hind tarsi paler brown. Fore tarsi with hairs no more than 2 times tarsal diameter. Empodium as long as claws; pulvilli minute (clearly visible only at 430 magnification). Fore tibia with a single spur; middle tibia with two short subequal spurs; hind tibia with the usual comb and with two spurs, of which the outer is about one-half the length of the inner. Ratio of spur length to diameter of tibia: foreleg, 8:8, middle leg, 3:8; hind leg (inner spur), 8:9.

Prothorax broad, almost parallel-sided to the apex where it projects slightly; halves distinctly notched; lateral margin with about 8 fine bristles. Wing length 1.62 mm; no supra-alar bristles; 2 prealar bristles; dorsomedial and dorsolateral bristles minute, in a single row, depressed; scutellar bristles 8, moderate sized, erect. Chaetotaxy of abdominal tergite II shown in Figure 25.

Leg proportions:

	F	Ti	Ta_1	2	3	4	5	Leg ratio
Foreleg	32	43	22	11	9	6	5	0.51
Middle leg	38	38	17	10	7	5	5	0.45
Hind leg	37	45	25	12	10	6	5	0.56

Wing structure appears to be the same as the allotype.

Genitalia, Figure 23. The strong, almost right angled basal lobe on the basistyle as well as the shape of the dististyle seem distinctive; dististyle in dorsal view, Figure 24.

Allotype: In the U. S. National Museum Collection. Collected at light, Natchitoches, Louisiana, 6-V-57.

Colored as the holotype male except that the dark areas are more intense; thoracic vittae fused completely so that mesothorax is almost solid black; pronotum also infuscate. Abdomen colored as male. Eyes reniform, more abbreviate dorsally. Legs dark, vittate appearance not discernible. Palpal proportions, 7:16:16:22; wing length 2.48 mm; venarum ratio 1.17; 4 prealar bristles; dorsomedial bristles apparently in a single row; dorsolateral bristles in a rather broad staggered row; scutellum with about 10 bristles in a slightly staggered row. Antennal proportions 12:8:8:8:22; ratio of terminal segment to remainder, 0.41.

Leg proportions:

	F	Ti	Ta_1	2	3	4	5	Leg ratio
Foreleg	40	47	25	15	11	8	5	0.53
Middle leg	38	40	19	11	8	5	5	0.47
Hind leg	35	43	24	12	10	6	5	0.56

Wing membrane greyish-brown by transmitted light, veins dark brown. C produced beyond R_{4+5}, terminating proximal to M and distal to Cu_1. R_{2+3} terminates at about the middle of the ends of R_1 and R_{4+5}. The anal vein terminates beyond f-Cu.

Genital lamella, Figure 26.

Paratype males: Wing length 1.31-1.44, mean 1.40 mm (3); leg ratio 0.51-0.52, mean 0.52 (3); antennal ratio 0.86-1.09, mean 0.97 (3).

Paratypes: One male, 6-IX-58; 3 males, 12-IX-58; 1 male, 4-X-58; 7 males, 29-X-58; 5 males, 6-XI-58; 1 male, 10-XI-58; 2 males, 27-XI-58; 3 males, 12-XII-58; 3 males, 10-I-59; U.S.F.H. In the collections of C.N.C., A.N.S.P., I.N.H.S., and Cornell University.

This species keys in Johannsen (in Johannsen and Townes), 1952, to *tricinctus* Meigen. Separation of *lebetis* from Palearctic material on the basis of color patterns is difficult. The genitalia as figured by Tokunaga (1936) is distinctively different.

PSECTROCLADIUS VERNALIS
Malloch

Psectrocladius vernalis Malloch, 1915a: 520, description of adult.

Psectrocladius vernalis Malloch; Dendy and Sublette, 1959: 513, added description of adult.

Males: Wing length 1.71-2.25, mean 1.87 mm (5); leg ratio 0.67-0.70, mean 0.69 (5); antennal ratio 1.00-1.26, mean 1.13 (5).

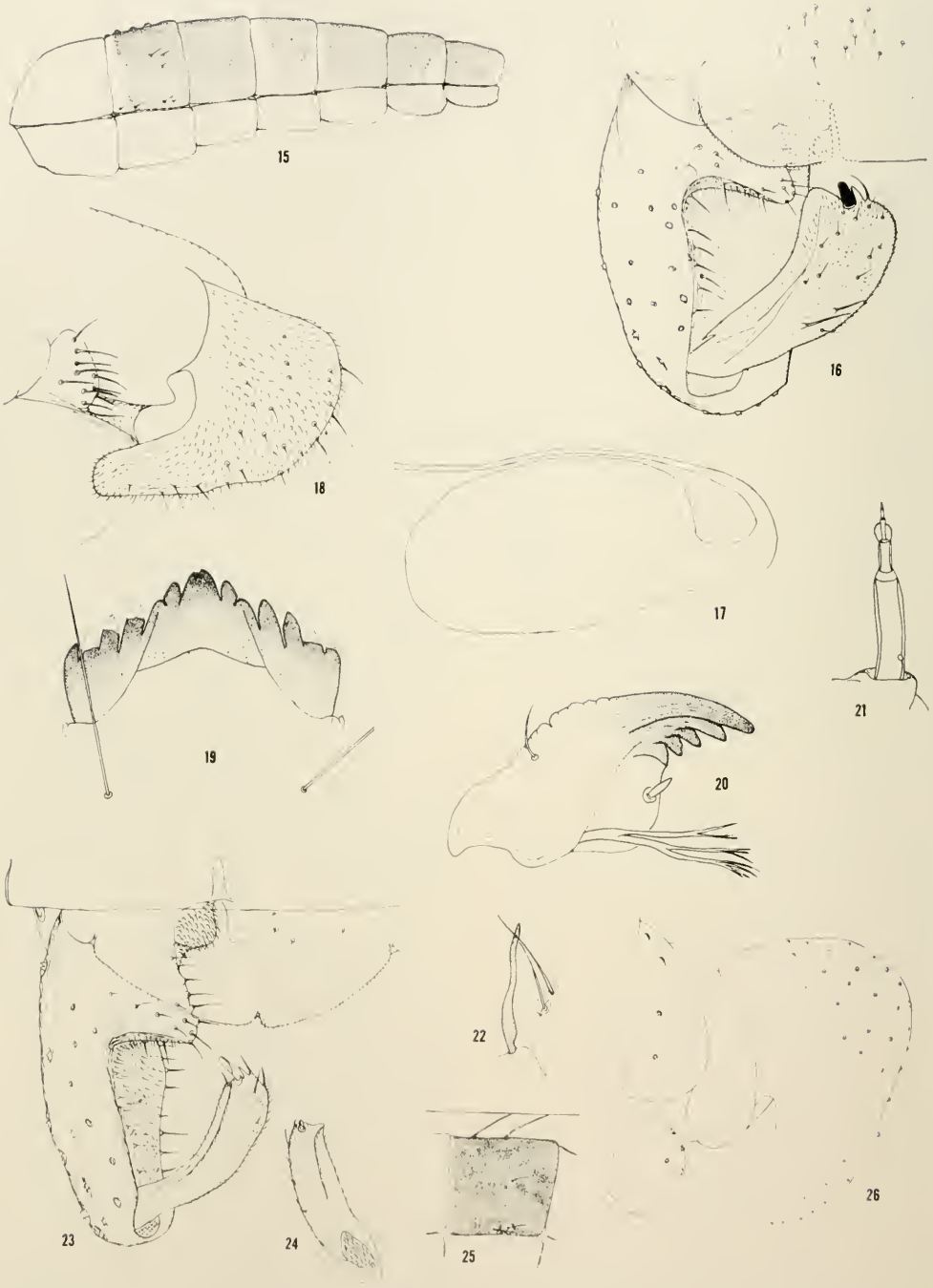
Material examined: One male, 4-X-58; 1 male, 10-X-58; 2 males, 15-X-58; 7 males, 29-X-58; 41 males, 6-XI-58; 1 male, 26-XI-58; 2 males, 27-XI-58; 109 males, 12-XII-58; 2 males, 10-I-59; 1 male, 15-I-59; 8 males, 25-I-59; 6 males, 5-II-59; 2 males, 9-II-59; 9 males, 15-II-59; U.S.F.H. One male, 3-II-57; 1 male, 5-II-57; 1 male, 6-II-57; C.R.L., on *Typha*. One male, 3-III-58; 1 mile south of Farmersville, La., borrow ditch.

Larva: Described from exuvia of reared male. Head length, 0.50 mm; head capsule pale yellow except for tips of mandibles and labial plate which is dark brown and occiput which is dark yellow. Labial plate, Figure 27; mandible, Figure 28; antenna, Figure 29; ventral surface of labrum somewhat obscured; epipharyngeal apparatus, Figure 30; Sm apparently absent; seta I palmate deeply and coarsely incised; seta II, simple, slightly anterior and lateral to seta I; seta III, small and simple, medial to seta II; about 8 chaetae; torma (premandible), Figure 31; maxilla with about 8 long medial blades; palpus about as long as wide; with about 8-10 low pointed scales medial to the palpus. Posterior end of exuvia lost.

The larva does not fit well into Roback's key (1957c, page 86), the most comprehensive treatment of Nearctic species. The labial plate resembles that of the Palearctic species *stratiotis* Kieffer (Goetghebuer, 1914, vide Roback, op. cit.) but differs in having the medial teeth distinctly less projecting.

Pupa: Described from exuvia of reared male. Length 4.5 mm. Entirely pale yellow; respiratory organs darker (Fig. 32). Cephalic tubercles low conical, each with a terminal seta. Tergites II-VI with a posterior transverse band of coarse spines and spinulae; tergites IV-VI with a central disc of coarse spines, consisting of 7 spines on IV, 13 spines of V, and 13 spines of VI. Tergite IV is shown in Figure 33. Segments VI and VII have 4 lateral flattened bristles, 2 anterior and 2 posterior; segment VII has 5 flattened bristles, 2 anterior and 3 posterior. Swim fin with about 28 fringe bristles and, in addition, 3 heavy, posteriorly directed spines. No intersegmental spinulae.

The pupa keys to *elatus* Roback in Roback's key (op. cit., page 87). It may be distinguished by the structure of the respir-



Figures 15-22. Cricotopus remus new species. 15. color pattern of male abdomen, lateral view; 16. male genitalia; 17. spermatheca of female; 18. genitalia of female; 19. labial plate of larva; 20. mandible; 21. antenna; 22. respiratory organ of pupa. **Figures 23-26. Cricotopus lebetis new species.** 23. male genitalia; 24. dististyle of male genitalia, dorsal view; 25. second tergite of male abdomen, lateral view; 26. female genitalia, microtrichae omitted.

atory organ (compare Fig. 32 and Roback's figure 244).

NANOCLADIUS ALTERNANTHERAE

Dendy and Sublette

Nanocladius alternantherae Dendy and Sublette, 1959: 510, description of larva, pupa and adult; ecology, phenology.

To the original description should be added: eyes hairy; postocular bristles two, dorsolateral to the eyes; dorsomedial bristles two, rather short and heavy, on a very slight mesonotal tubercle; middle tibia with two spines, the inner slightly shorter than the outer (in the original description the outer mesotibial spur apparently was obscured or missing); small pulvilli present; scutellum with four bristles.

As Freeman (1961) pointed out, his earlier (1954) synonomy of *Nanocladius* was too broad. I consider his synonomy of *Microcricotopus* with *Nanocladius* to be valid but the other genera which he synonomized not so. The valid genera then appear to be (after Brundin, 1956): *Nanocladius* Kieffer (synonym *Microcricotopus* Thienemann and Harnisch); *Eukiefferiella* Thienemann (synonym *Akiefferiella* Thienemann); *Parakiefferiella* (Thienemann) Brundin; *Krenosmittia* Thienemann (synonym *Camptokiefferiella* Goetghebuer).

The two other Nearctic species *sordens* Johannsen and *brevinervis* Malloch, provisionally placed in *Nanocladius* by Dendy and Sublette (1959), do not appear to belong here in the restricted genus. The position of *brevinervis* most probably is in *Eukiefferiella*, while that of *sordens* is uncertain. Johannsen's very brief original description did not mention hairy eyes so possibly this is also a species of *Eukiefferiella* in its restricted sense. A reexamination of the type will be needed before a positive placement can be given.

Material examined: Two females, 2-II-57; 2 females, 6-II-57; 1 male, 6-V-57; 1 male, 25-VI-57; 2 females, 2-VII-57; 1 female, 9-VII-57; 1 male, 11-VII-57; 1 male, 27-VII-57; 1 male, 30-VII-57; 5 males, 8 females, 24-IX-57; 1 male, 30-IX-57; 1 male, 1-X-57; 1 male, 29-X-57; 1 female, 11-XI-57; 2 males, 25-XI-57; 1 male, 1 female, 2-XII-57; 1 female, 23-XII-57; 1 male, 28-I-58; C.R.L. One female, 25-VII-56; Ch.L.

Subfamily Chironominae

Tribe Chironomini

PSEUDOCHIRONOMUS AIX Townes

Pseudochironomus aix Townes, 1945: 19, description of adult.

Pseudochironomus aix Townes; Beck and Beck, 1959: 92, distribution; phenology.

Immature stages were reared from specimens collected on alligator weed (*Alternanthera philoxeroides* (Mart.) Standl.).

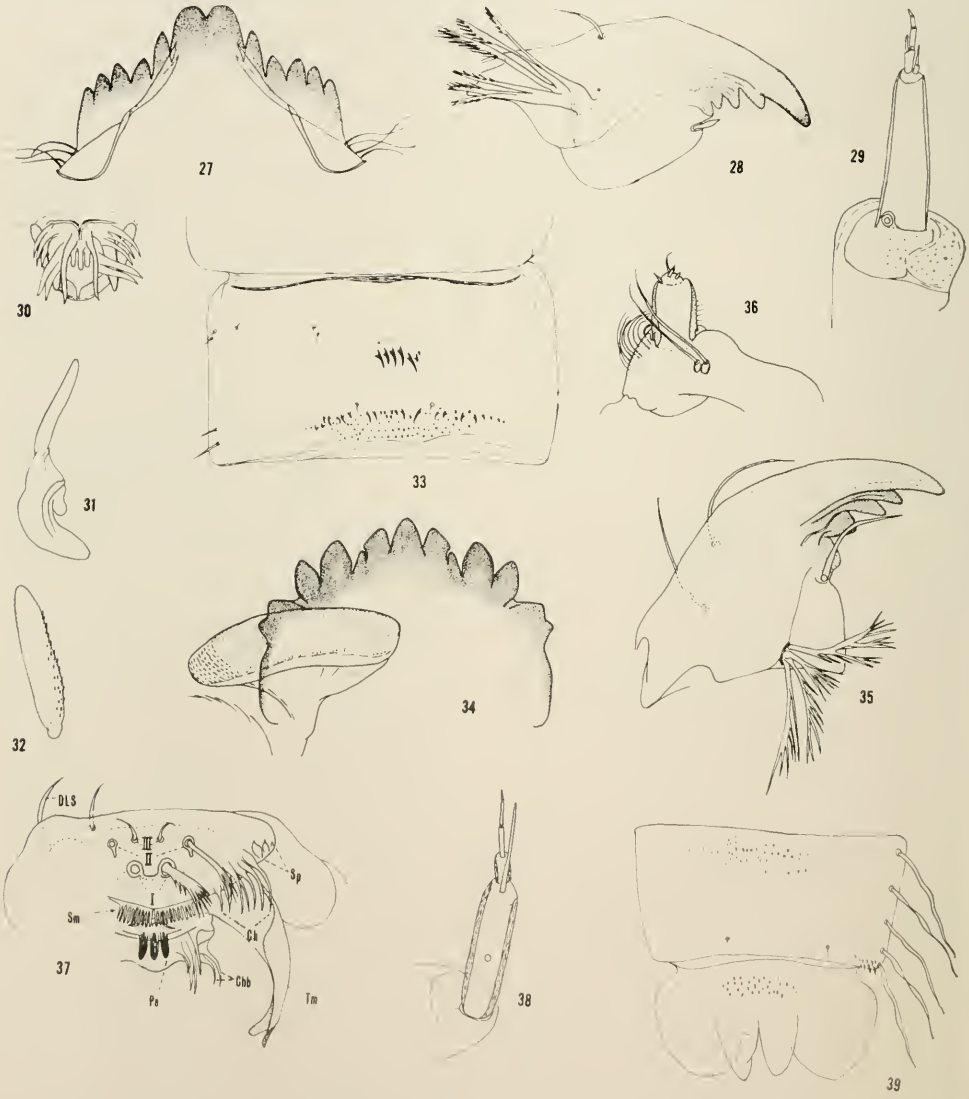
Larva: Head pale except for brownish teeth of labial plate and mandible; gular area yellowish. Head capsule length 0.53 mm. Labial plate (Fig. 34) very similar to that figured for *Tanytarsus* (sens. lat.) sp. J (Johannsen, 1937a) (?=*Pseudochironomus pseudoviridis* (Malloch), cf. Sublette, 1957) and *fulviventris* (Johannsen) (cf. Hauber, 1947). Mandible (Fig. 35) also very similar to the two species mentioned. Maxilla, epipharyngeal apparatus, and antenna are shown in Figures 36, 37 and 38. Preanal tubercles more or less quadrate, about as high as wide. Each supports 9 long yellowish bristles. On the anterior face of each tubercle are 2 fine bristles while the membrane posterior and inferior to the tubercle supports one longer, heavier bristle. Anal legs each with about 14 strongly hooked, yellowish claws.

Pupal exuvia: Length 4.44 mm. Thorax yellowish-brown, somewhat papillose on dorsal surface; low spinules on either side of anterior margin of raphe. Respiratory organs not discernible.

Tergal chaetotaxy of abdomen as follows: Segment I, devoid of spinules. Segment II, with a transverse band of shagreen towards the anterior margin; posteriorly there is a less definite triangular band of finer shagreen; along the midline the two bands are joined by fine shagreen. At the posterior margin is the usual heavy band of blackish upturned hooks, which is made up of 95 hooks in an even straight row. Segment III, similar to II, with an anterior definite band joined to a fainter posterior area of shagreen. Intersegmental membrane with a few fine black spinulae. Segment IV, similar to III but with the tergal surface behind the anterior band almost uniformly and finely shagreened. Intersegmental membrane between IV and V with several rows of blackish spinulae. Segment V, anterior band composed of a lateral area of heavy shagreen,

joined across middle by fine shagreen; posterior half of tergite finely shagreened except for bare lateral areas; margin of segment with 3 large flattened bristles, 2 close together near anterior one-fourth and the third beyond the middle. Segment VI, as V except spinulae less dense and posterior area narrower, leaving wider marginal clear areas; lateral bristles as V. Segments VII and VIII, with an anterior band only (Tergite VIII, Fig. 39). The lateral bristles of VII as the preceding two segments. Segment IX, central part of disc with a band of coarse spinulae (Fig. 39); swim fin with a fringe of 37 to 40 bristles.

Males: Wing length 1.66-2.18, mean 1.91



Figures 27-33. Psectrocladius vernalis Malloch. 27. labial plate of larva; 28. mandible; 29. antenna; 30. epipharyngeal apparatus; 31. torma (premandible); 32. pupal respiratory organ; 33. fourth abdominal tergite of pupa. **Figures 34-39. Pseudochironomus aix Townes.** 34. labial plate of larva; 35. mandible; 36. maxilla; 37. epipharyngeal apparatus—abbreviations as follows: Pe = pecten epipharyngis Chb = chaetulae basales Tm = torma (= premandible) Ch = chaetae Sm = squama platia I = seta I II = seta II III = seta III Sp = spinulae DLS = dorsal labral setae; 38. antenna; 39. tergite VIII of pupa, and anal fin.

mm (10); leg ratio 0.84-0.93, mean 0.89 (10); antennal ratio 2.00-2.47, mean 2.22 (8).

Material examined: One female, 11-VII-57; 1 male, 29-VIII-57; 1 male, 1 female, 3-IX-57; 1 male, 10-IX-57; 1 female, 14-X-57; 1 female, 21-X-57; 1 male, 7-IV-58; 1 female, 30-IV-58; 4 males, 4 females, 5-V-58; 3 males, 6 females, 12-V-58; 3 males, 2 females, 4-VI-58; 3 males, 3 females, 6-VI-58; 3 males, 3 females, 19-VI-58; 3 females, 2-VII-58; on alligator weed, C.R.L.

CHIRONOMUS (CHIRONOMUS) STIGMATERUS Say

Chironomus stigmaterus Say, 1823: 15, description of adults.
Tendipes (Tendipes) stigmaterus (Say); Townes, 1945: 120, added description of adult; distribution and phenology.
Chironomus (Chironomus) stigmaterus Say; Beck and Beck, 1959: 94, distribution and phenology of adults.
Tendipes (Tendipes) stigmaterus (Say); Sublette, 1960: 211, adults.

Males: Wing length 4.55, 4.95 mm (2); leg ratio 1.44 (1); antennal ratio 4.55, 5.00 (2).

Material examined: One pupal exuvia, 10-X-58; 1 male, 1 female, 27-XI-58; 1 pupal exuvia, 12-XII-58; 1 pupal exuvia, 25-I-59; 1 pupal exuvia, 15-II-59; U.S.F.H. One male, 14-V-57; at light, Natchitoches, La.

CHIRONOMUS (CHIRONOMUS) ATTENUATUS Walker

Chironomus attenuatus Walker, 1848: 20, description of adult.
Tendipes (Tendipes) decorus (Johannsen) Townes, 1945: 20, adults.
Tendipes decorus [(Johannsen)]; Gerry, 1951: 241-244, ecology; control.
Tendipes (Tendipes) decorus (Johannsen); Roback, 1953: 129, ecology.
Tendipes decorus (Johannsen); Jamnback, 1954: 1-36, ecology; control.
Tendipes decorus (Johannsen); Jamnback and Collins, 1955: 1 ecology; control.
Tendipes (Tendipes) decorus (Johannsen); Neff, 1955: 10, larva, pupa and adult; ecology.
Tendipes (Tendipes) decorus (Johannsen); Tebo, 1955: 96, ecology.
Tendipes decorus (Johannsen); Jamnback and Collins, 1956: 1-5, ecology; control.
Chironomus decorus Johannsen; Paine and Gaufin, 1956: 296, ecology.
Tendipes decorus (Johannsen); Judd, 1957: 401, phenology.
Tendipes (Tendipes) decorus (Johannsen) Roback, 1957b: 17, distribution of adult; 1957c: 113, description of larva and pupa.
Tendipes (Tendipes) decorus (Johannsen); Sublette, 1957: 390, ecology; phenology.
Chironomus decorus (Johannsen); Gaufin, 1958: 202, and following pages, ecology.
Tendipes (Tendipes) decorus (Johannsen); Dendy and Sublette, 1959: 514, adults.
Chironomus (Chironomus) decorus Johannsen; Beck and Beck, 1959: 94, distribution of adults; phenology.
Tendipes decorus [(Johannsen)]; Provost and Branch, 1959: 49-62, ecology.
Tendipes (Tendipes) attenuatus (Walker); Townes, 1959: 135, synonomy; notes on type.
Tendipes (Tendipes) decorus (Johannsen); Davis, 1960: 212, distribution of adults; phenology.
Tendipes (Tendipes) attenuatus (Walker); Darby, 1962: 161, ecology.

Males: Wing length 2.93-4.05, mean 3.41 mm (4); leg ratio 1.61-1.84, mean 1.70 (4); antennal ratio 3.75-4.10, mean 3.92 (3).

Material examined: One male, 27-X-55; 1 female, 8-II-56; 1 female, 9-II-56; 1 female, 3-II-57; 2 females, 5-II-57; 1 female, 17-IV-57, Ch.L. One male, 6-II-57; 1 male, 21-X-57; 1 male, 4-XI-57; 1 male, 19-21-III-58; 1 male, 12-V-58; C.R.L. One male, 18-V-54; 1 male, 11-X-56; 3 males, 14-I-57; 2 males, 14-II-57; 2 males, 15-II-57; 1 male, 28-II-57; 3 males, 3 females, 2-III-57; 2 males, 1 female, 3-III-57; 1 male, 10-III-57; 1 male, 11-III-57; 5 males, 2 females, 12-III-57; 3 males, 13-III-57; 2 males, 28-III-57; 4 males, 5-IV-57; 3 males, 8-IV-57; 1 male, 9-IV-57; 4 males, 12-IV-57; 2 males, 16-IV-57; 1 male, 29-IV-57; 1 male, 6-V-57; 3 males, 14-V-57; 2 males, 15-V-57; 1 male, 21-V-57; 2 males, 16-VI-57; 12 males, 28-VI-57; at light, Natchitoches, La.

CHIRONOMUS (CHIRONOMUS) FULVIPILUS Rempel

Chironomus fulvipilus Rempel, 1939: 210, description of adult.
Tendipes (Tendipes) fulvipilus (Rempel); Townes, 1945: 119, adults.
Tendipes (Tendipes) fulvipilus (Rempel); Dendy and Sublette, 1959: 514, adults.
Chironomus (Chironomus) fulvipilus Rempel; Beck and Beck, 1959: 94, adults; distribution; phenology.
Tendipes (Tendipes) fulvipilus (Rempel); Sublette, 1960: 211, adults.

Larva and pupa have been associated by rearing in other studies by the author and will be described elsewhere.

Material examined: One male, 7-IX-56; C.R.L.

CHIRONOMUS (CHIRONOMUS) NATCHITOCHEAE new species

(*Einfeldia* group)

Holotype male: U.S.N.M., No. 66457. Collected at the U. S. Fish Hatchery, Natchitoches, Louisiana, 20-VIII-58, R. F. Tyler.

Head brownish; antennal pedicel blackish-brown; antennal flagellum dark brown; antennal ratio 3.00; frontal tubercles large and conspicuous, 0.07 mm long; palpi dark; ratio, 5:12:20:27. Mesothorax yellowish-brown; vittae, postnotum and sternopleuron blackish-brown; mesonotum with a slight central hump; scutellum infuscate; halteres dark; wing length 2.61 mm; dorsolateral bristles in a single row, sparse. Forelegs darkened on distal one-third of femur, and tarsal segments 2 to 5; middle and hind legs darkened on distal two-thirds of femur, basal one-third of tibia and tarsal segments 3 to 5; combs of middle and hind legs with two short spurs of about equal length. Foretarsus without a beard. Wings without macrotrichiae but with conspicuous microtrichiae. Abdomen entirely blackish-brown.

Leg proportions:

	F	Ti	Ta_1	2	3	4	5	Leg ratio
Foreleg	57	40	88	44	34	28	11	2.20
Middle leg	58	50	30	15	10	5	4	0.60
Hind leg	60	65	48	23	17	10	6	0.74

Genitalia very similar to *chelonia* Townes but differs in having a more clavate dististyle. Figure 40 shows the normal view; Figure 41 shows anal point and superior appendage in lateral view.

Allotype: In the Collection of the U. S. National Museum. Collected at the U. S. Fish Hatchery, 4-X-58, R. F. Tyler.

Coloration and other features similar to male except for sexual differences. The mesonotal hump is more conspicuous than in the male. Wing length 3.15 mm.

Leg proportions:

	F	Ti	Ta_1	2	3	4	5	Leg ratio
Foreleg	60	45	98	38	33	27	12	2.18
Middle leg	65	55	32	16	12	6	5	0.58
Hind leg	68	70	50	23	18	11	8	0.71

Lamellae of genitalia scarcely produced ventrally, almost quadrate in outline, (Fig. 42).

This species keys to *brunneipennis* (Johannsen) in the key given by Townes (1945, page 111). It may be distinguished from that species by having the anal point of the genitalia broadened rather than narrow and by differences in the superior appendage.

Paratype males: Wing length 2.39-2.70, mean 2.54 mm (4); leg ratio 1.85, 2.00 (2); antennal ratio 2.82-3.10, mean 2.93 (4).

Paratypes: Two females, 3-V-57; C.R.L. One male, 12-VIII-58; 7 males, 20-VIII-58; 5 males, 6-IX-58; 9 males, 12-IX-58; 21 males, 20-IX-58; 1 male, 1 pupal exuvia, 27-IX-58; 3 males, 2 females, 2 pupal exuviae, 4-X-58; 2 males, 1 pupal exuvia, 15-X-58; U.S.F.H. In the collections of the U.S.N.M., C.N.C., A.N.S.P., I.N.H.S., Cornell University, and Florida State Board of Health.

Larva: Described from exuvia associated with reared adult. Head length 0.59 mm; capsule ventrally darkened; tips of mandibles, torma, labial plate, and narrow occipital border, black. Labial plate as in Figure 43; mandible, Figure 44; antenna, Figure 45. Epipharyngeal area similar to other Chironomini: Pe, somewhat pulvilliform, Figure 46; Chb, 7 in number, finely serrate; torma, black tipped, distally with the usual bifurcation; Ch, 6 in number; Sm, finely pectinate; teeth not clearly discernible but in excess of 25 on each side; seta I, palmate, with very fine teeth; seta II, long, curving and unbranched; seta III, minute, medial to II and almost contiguous with it; Sp, small and inconspicuous.

Preanal papillae very short, each with 5 to 6 rather short, terminal yellowish bristles. Anal prolegs with about 18 long, curved, yellow claws.

Pupa: Described from exuviae. Length 8.00 mm; almost entirely blackish. Cephalic tubercle long and pointed with a conspicuous preapical bristle. Respiratory organs white with numerous branches, apparently arising from 3 main branches. Tergites II-VI with an anterior and posterior transverse band of spinulae, each tergite with a central, laterally more restricted patch of spinulae (Fig. 47). Segment II with the usual posterior row of upturned hooks; about 81 hooks in the row. Intersegmentalia between III-IV, with a few spinulae; between IV-V and V-VI, heavily spinose. Posterolateral comb of segment VIII shown in Figure 48; caudal fin with about 116 fringe bristles in an irregular double row.

The larva cannot clearly be distinguished from the Palearctic species *Chironomus (Chironomus) insolita* Kieffer (*Einfeldia*

group) on the basis of the description available to me.

The pupa is distinguished from all other Nearctic *Chironomus (Chironomus)* on the basis of having a posterolateral comb of only 3 teeth. It might be confused with certain species of *Chironomus (Cryptochironomus)* but these are usually smaller

Figures 40-48. Chironomus (Chironomus) natchitocheae new species. 40. genitalia of male; 41. anal point and superior appendage in lateral view; 42. female genitalia; 43. labial plate of larva; 44. mandible; 45. antenna; 46. pecten epipharyngis; 47. tergite chaetotaxy of pupa; 48. posterolateral margin of Segment VIII.

in size and the spines of the posterolateral comb are finer and paler.

CHIRONOMUS (DICROTENDIPES) MODESTUS Say

Chironomus modestus Say, 1823: 13, description of adult.
Tendipes (Limnochironomus) modestus (Say); Townes, 1945: 106, adults; generic position.
Tendipes (Limnochironomus) modestus (Say); Hauber and Morrissey, 1945: 288, description of larva, pupa and adult; phenology.
Tendipes (Limnochironomus) modestus (Say); Neff, 1955: 9, larva, pupa and adult; ecology.
Tendipes (Limnochironomus) modestus (Say); Tebo, 1955: 96, ecology.
Tendipes (Limnochironomus) modestus (Say); Roback, 1957c: 111, larva and pupa.
Chironomus (Limnochironomus) modestus (Say); Beck and Beck; 1959: 94, distribution and phenology of adults.
Tendipes (Dicrotendipes) modestus (Say); Dendy and Sublette, 1959: 514, description of adult; generic position.
Tendipes (Dicrotendipes) modestus (Say); Sublette, 1960: 218, adult.
Tendipes (Dicrotendipes) modestus (Say); Darby, 1962: 38, 51, 54, 101, 158, adult.

Males: Wing length 2.11-2.70, mean 2.40 mm (4); leg ratio 1.66-1.86, mean 1.78 (3); antennal ratio 2.60-2.87, mean 2.74 (4).

Material examined: Four males, 29-III-54; 1 male, 12-IV-57; 1 male, 16-IV-57; 1 male, 6-V-57; 1 male, 16-VII-57; Natchitoches, La. One male, 5-II-57; Ch.L.

CHIRONOMUS (DICROTENDIPES) NERVOSUS Staeger

Chironomus nervosus Staeger, 1839: 567, description of adult.
Tendipes (Limnochironomus) lucifer (Johannsen); Hauber and Morrissey, 1945: 288, description of larva, pupa and adult; phenology.
Tendipes (Limnochironomus) nervosus (Staeger); Townes, 1945: 102, 103, 108, taxonomy.
Limnochironomus nervosus [(Staeger)], Wohlschlag, 1950: 343, ecology.
Limnochironomus nervosus [(Staeger)], Mundie, 1955: 578, ecology.
Limnochironomus nervosus [(Staeger)], Palmen, 1955: 20, ecology.
Tendipes (Limnochironomus) nervosus (Staeger); Anderson and Hooper, 1956: 262, ecology.
Limnochironomus nervosus (Staeger); Mundie, 1957: 165, ecology.
Tendipes (Limnochironomus) nervosus (Staeger); Sublette, 1957: 390, ecology.
Tendipes (Limnochironomus) nervosus (Staeger); Roback, 1957c: 110-111, larva, pupa, in key.
Chironomus (Limnochironomus) nervosus Staeger; Beck and Beck; 1959: 94, distribution and phenology of adults.
Tendipes (Dicrotendipes) nervosus (Staeger); Dendy and Sublette, 1959: 514, generic position.
Tendipes nervosus (Staeger); Judd, 1960: 207, phenology.
Tendipes (Limnochironomus) nervosus (Staeger); Davis, 1960: 71 and following pages, ecology.
Tendipes (Dicrotendipes) nervosus (Staeger); Sublette, 1960: 220, adult.
Tendipes (Limnochironomus) nervosus (Staeger); Buscemi, 1961: 294, ecology.
Tendipes nervosus (Staeger); Judd, 1961: 96, phenology.
Tendipes (Limnochironomus) nervosus (Staeger); Darby, 1962: 158, ecology.

Males: Wing length 1.70-1.79, mean 1.76 mm (3); leg ratio 1.87-2.17, mean 2.00 (3); antennal ratio 2.27-2.67, mean 2.46 (3).

Material examined: Seven males, 7-IX-56; 2 males, 11-IX-56; 2 males, 6-II-57; 2 males, 2-VII-57; 1 male, 2 females, 16-VII-57; 2 males, 18-VII-57; 2 males, 20-VIII-57; 2 males, 22-VII-57; 1 male, 23-VII-57; 1 female, 27-VII-57; 1 male, 1 female, 30-VII-57; 1 male, 1-VIII-57; 4 males, 6-VIII-57; 2 males, 13-VIII-57; 1 male, 20-VIII-57; 2 males, 27-VIII-57; 1 female, 29-VIII-57; 4 males, 30-IX-57; 1 male, 7-X-57; 4 males, 14-X-57; 7 males, 21-X-57; 2 males, 5-V-58; 1 male, 12-V-58; 1 male, 10-VI-58; C.R.L. Two males, 29-III-54; 1 male, 18-V-54; 1 male, 28-II-57; 1 male, 2-III-57; 1 male, 12-III-57; 2 males, 13-III-57; 1 male, 26-III-57; 2 males, 28-III-57; 2 males, 5-IV-57; 1 male, 8-IV-57; 1 male, 12-IV-57; 1 male, 14-V-57; 2 males, 21-V-57; 2 males, 16-VI-57; 2 males, 28-VI-57; 2 males, 16-VII-57; 2 males, 22-VII-57; at light, Natchitoches, La.

CHIRONOMUS (DICROTENDIPES) **INCURVUS** new species

Holotype male: U.S.N.M., No. 66458; U. S. Fish Hatchery, Natchitoches, Louisiana 27-IX-58, R. F. Tyler.

Head and thorax pale stramineous; abdomen pale; antennal flagellum and front tarsus beyond middle of basitarsus darkened. Pronotum scarcely narrowed medially, only slightly inferior to anterior edge of mesonotum; mesoscutum with a slight hump. Frontal tubercles exceedingly small, scarcely visible at 100 magnification. Palpal proportions 7:10:15:22. Antennal ratio 1.88.

Wing length 1.80 mm; no supra-alar bristles; prealar bristles 3; dorsomedial bristles decumbent, apparently in one row; dorsolateral bristles in one row, erect; scu-

tellar bristles 8, large, in a straight transverse row, anteriorly are 2 smaller bristles, one on either side of the midline.

Leg proportions:

	F	Ti	Ta_1	2	3	4	5	Leg ratio
Foreleg	48	35	66	30	25	22	10	1.89
Middle leg	42	35	21	11	7	5	5	0.60
Hind leg	45	52	32	18	13	8	5	0.61

Fore tarsus without a beard.

Wing veins scarcely darkened, membrane clear; venarum ratio 1.12.

Genitalia very similar to *nervosus* Staeger but with an inturned superior appendage which is distinctive (Fig. 49).

Allotype female: In the U. S. National Museum Collection; collected at the U. S. Fish Hatchery, 6-XI-58, R. F. Tyler.

Head somewhat darkened, thoracic vittae, postnotum and mesosternum brown; forelegs beyond middle of femora, middle and hind tarsi, antennal flagellum, palpi and genital lamellae infuscate. Thoracic chaetotaxy as holotype male. Palpal proportions, 5:14:15:25. Antennal segment proportions, 15:10:10:10:15.

Wing length 2.48 mm; venarum ratio 1.11.

Leg proportions:

	F	Ti	Ta_1	2	3	4	5	Leg ratio
Foreleg	55	42	75	31	26	23	11	1.79
Middle leg	50	47	25	12	8	5	5	0.53
Hind leg	53	65	37	19	16	8	5	0.57

Abdomen pale. Genital lamellae quadrate (Fig. 50); spermatheca ovoid, 0.11 x 0.08 mm, seminal duct emerging eccentric; ducts and spermatheca colorless (Fig. 51).

Paratype males: Wing length 1.62-1.80, mean 1.73 mm (3); leg ratio 1.90-1.94, mean 1.92 (3); antennal ratio 2.00-2.21, mean 2.11 (3).

Paratypes: Three males, 20-VIII-58; 8 males, 12-IX-58; 6 males, 20-IX-58; 5 males, 27-IX-58; 9 males, 15-X-58; 9 males, 29-X-58; 14 males, 1 female, 6-XI-58; 1 male, 15-II-59; U.S.F.H. One male, 24-XI-59; Chivary Dam Spillway, Natchitoches Parish, La. In the collection of A.N.S.P., Florida State Board of Health, C.N.C., I.N.H.S., and Cornell University.

This species may be distinguished from all other Nearctic species by the male genitalia, which are similar to *nervosus* but differ in having an inturned superior appendage.

Larva: Described from exuvia of reared male. Head length 0.50 mm. Head capsule yellowish except for tips of mandibles and labial plate. Mandible (Fig. 52) not at all like *nervosus* but rather more like *modestus* (cf. Hauber and Morrissey, 1945, figure 10). Mandible length 0.16 mm. Labial plate, (Fig. 53) also similar to *modestus*. In the single larva available, the details of the epipharyngeal area were obscured. The premandible (torma) is yellowish and appears to be bifurcate. The antennae are also obscured in that they do not lie in a flat plane. Segment 3 appears shorter than 2 and 4 which are approximately subequal in length. The posterior part of the larval exuviae was lost.

Pupa: Described from exuvia of reared male and other exuviae compared with it. Exuvia dark yellowish-brown; length 4.5 mm. Respiratory organs a tuft of many white filaments. Cephalic tubercles short (0.04 mm) and conical, each with a fine preapical bristle. Abdominal tergites II to VI with fine shagreen, that of II occurring in a longitudinal band on either side of the midline, that of III to VI occupying most of the tergite. Segment II with the usual row of hooks along the posterior margin; the row consists of about 80 fine, yellowish hooks. Sternites I and II with a posterior band of colorless needle-like elongate spines; sternite III with a similar band of less elongate spines at about the anterior one-third; lateral margins of segments VI to VIII each with 4; flattened bristles, 2 in the anterior half and 2 in the posterior. Abdominal segment VIII with a conspicuous double spur (Figs. 54, 55 for variation). Swim fin with about 65 flattened filaments.

The larva keys in Roback (1957c, pages 109, 110) to *fumidus* Johannsen. It differs from *fumidus* by having the most laterad tooth of the labial plate appearing as a lateral shelf on the fifth tooth, and by having all mandibular teeth darkened.

The pupa keys to couplet 16 (page 111, op. cit.). It may be distinguished from *modestus* Say and *neomodestus* Malloch by a higher number of filaments in the swim fin (about 65) and by the distinctively different caudolateral spur of segment 8.

Figures 49-55. Chironomus (Dicrotendipes) incurvus new species. 49. male genitalia; 50. female genitalia; 51. spermatheca and duct; 52. larval mandible; 53. labial plate; 54. posterolateral spur of Segment VIII of pupa; 55. variation of posterolateral spur.

CHIRONOMUS (XENOCHIRONOMUS) XENOLABIS Kieffer

Chironomus xenolabis Kieffer (in Thienemann and Kieffer, 1916): 526, description of adult.
Xenochironomus xenolabis (Kieffer); Townes, 1945: 92, description of adult.
Xenochironomus xenolabis (Kieffer); Beck and Beck, 1959: 93, distribution and phenology of adult.

Males: Wing length 2.25-2.47, mean 2.38 mm (3); leg ratio 1.70 (1); antennal ratio 2.40-2.70, mean 2.46 (3).

Material examined: Three males, 2 females, 17-IX-57; 1 male, 24-IX-57; C.R.L. One male, 16-VII-57; at light, Natchitoches, La.

CHIRONOMUS (ENDOCHIRONOMUS) NIGRICANS Johannsen

Chironomus nigricans Johannsen, 1905: 219, description of larva, pupa and adult.
Tanytarsus (Endochironomus) nigricans (Johannsen); Townes, 1945: 64, description of adult.
Tanytarsus nigricans (Johannsen); Judd, 1949: 9, phenology.
Tanytarsus (Endochironomus) nigricans (Johannsen); Berg, 1950: 97-98, ecology.
Tanytarsus nigricans (Johannsen); Judd, 1953: 813, phenology.
Tanytarsus (Endochironomus) nigricans (Johannsen); Roback, 1953: 129, ecology.
Tanytarsus (Endochironomus) nigricans (Johannsen); Anderson and Hooper, 1956: 282, ecology.
Endochironomus nigricans (Johannsen); Paine and Gaufin, 1956: 296, ecology.
Tanytarsus (Endochironomus) nigricans (Johannsen); Roback, 1957c: 120, larva and pupa.
Tanytarsus nigricans (Johannsen); Judd, 1957: 401, phenology.
Endochironomus (Endochironomus) nigricans (Johannsen); Beck and Beck, 1959: 93, distribution and phenology of adult; generic position.
Tendipes (Endochironomus) nigricans (Johannsen); Dendy and Sublette, 1959: 514, adult; generic position.
Tanytarsus nigricans (Johannsen); Judd, 1960: 207, phenology.
Tanytarsus (Endochironomus) nigricans (Johannsen); Davis, 1960: 71 and following pages, ecology.
Tendipes (Endochironomus) nigricans (Johannsen); Sublette, 1960: 216, adult.
Tanytarsus nigricans (Johannsen); Judd, 1961: 96, phenology.
Tendipes (Endochironomus) nigricans (Johannsen); Darby, 1962: 157, ecology.

Males: Wing length 2.70-3.15, mean 2.93 mm (3); leg ratio 1.30, 1.32 (2); antennal ratio 2.67-3.05, mean 2.88 (3).

Material examined: Three males, 1 female, 17-IV-57; 4 males, 13-VIII-57; 1

male, 27-VIII-57; 1 male, 4-XI-57; 1 male, 10-IX-57; 1 male, 7-X-57; 5 males, 21-IV-58; 3 males, 4-VI-58; 1 male, 6-VI-58; 1 male, 10-VI-58; C.R.L. Two males, 20-IX-58; 2 males, 27-IX-58; U.S.F.H. Two males, 28 II-57; 1 male, 9-IV-57; 5 males, 29-IV-57; 2 males, 6-V-57; 5 males, 15-V-57; 2 males, 21-V-57; 1 male, 28-VI-57; at light, Natchitoches, La.

CHIRONOMUS (CRYPTOCHIRONOMUS) **PONDEROSUS** new species

Holotype male: U.S.N.M. No. 66459. Collected in a funnel trap, Cane River Lake, Natchitoches Parish, Louisiana, 19-V-58, B. R. Buckley.

Antennal pedicel yellowish-brown; antennal flagellum dark; antennal ratio 3.25; frontal tubercles absent; palpi slightly darkened, proportions, 7:25:20:32.

Thorax yellowish with vittae, postnotum, and sternopleuron golden brown; wing length 2.70 mm; prealar bristles 7; dorsomedial bristles in one row, erect; scutellar bristles about 14 in straight transverse row.

Legs yellowish with fore tibia, entire fore tarsus, and last 4 segments of middle tarsus darkened; hind tarsi missing. Fore tarsal beard absent.

Leg proportions:

	F	Ti	Ta_1	2	3	4	5	Leg ratio
Fore leg	65	53	95	48	38	21	12	1.79
Middle leg	65	57	35	16	11	6	5	0.61
Hind leg	75	75	–	–	–	–	–	–

Abdomen yellowish-green. Genitalia very similar to *fulvus* (Johannsen) Townes, but differs in having a spatulate anal point and by having the basistyle and dististyle less massive, with the latter slightly curved (Figs. 56, 57).

Allotype female: In U.S.N.M. Lake Oberlin, Bryan Co., Oklahoma, 21-VII-62, reared from larva collected in silty-mud at 0.80 meters.

Antennal pedicel and antennal flagellum pale except terminal segment which is dark; palpi infuscate; proportions 6:20:16:30.

Thorax ground color stramineous; vittae, sternopleuron, and postnotum ocherous. Mesothorax with a conspicuous hump. Wing length 2.25 mm; 1 supra-alar bristle; dorsomedial bristles long, erect, in one row; dorsolateral bristles long, erect, in one staggered row; scutellar bristles 15, in a long, posterior, straight, transverse row; 8 slightly shorter in anterior straight row, anterolateral bristles 4. Halteres pale.

Fore femora and tibiae dark; remainder of forelegs missing; middle and hind legs pale except for terminal 2 tarsal segments which are dark.

Leg proportions:

	F	Ti	Ta_1	2	3	4	5	Leg ratio
Fore leg	55	42	–	–	–	–	–	–
Middle leg	52	46	29	13	9	5	5	0.63
Hind leg	55	55	40	18	15	8	6	0.73

Abdomen pale greenish. Genitalia, Figure 58.

Paratype males: Wing length 2.22-2.48, mean 2.36 mm (3); leg ratio 1.76-1.80, mean 1.78 (3); antennal ratio 3.22-3.50, mean 3.24 (3).

Paratypes: One male, 1 pupal exuvia, 13-VIII-57; 1 male, 2 pupal exuviae; 28-VIII-57; 1 pupal exuvia, 7-X-57; C.R.L. One male, 14-VI-62; 1 male, 18-VI-62; 4 males, 29-VI-62; 1 male, 20-VII-62; 3 pupal exuviae, 25-VII-62; at light, University of Oklahoma Biological Station, Willis, Okla. In the collections of C.N.C., A.N.S.P. and I.N.H.S.

This species is one of the *fulvus* group; the adult male is distinguishable by the genitalia with their long anal point, which is slightly spatulate apically.

Larva: Described from exuvia of reared allotype; associated by distinctive pupal armature.

Head dark yellow; tips of labium and mandible strongly contrasting black; head capsule 5.95 mm long. Labium (Fig. 59) very similar to *digitatus* (cf. Curry, 1958). Paralabial plates as other members of this group. Mandible (Fig. 60) also very similar to that of *digitatus* but with the accessory tooth longer and more attenuate. Antenna (Fig. 61) almost identical with that of *digitatus* but with a basal segment shorter relative to that of *digitatus;* ratio, 50:30:23:2:1. Premandible (torma) obscured on the single specimen available. The epipharyngeal area does not differ significantly from that illustrated by Curry (1958, figure 1) for *digitatus.* The jointed labral bristles are apparently only two segmented. Maxilla, Figure 62.

Anal prolegs each with about 15 curved yellowish spines; preanal papillae each with 8 bristles.

Pupa: Exuviae pale yellowish; the ce-

phalic tubercles (Figs. 63, 64) darker yellow. Exuviae length 6.5 mm. Respiratory organs consist of numerous white filaments. Abdominal tergite I with a conspicuous anterior lateral spinose tubercle on each side; tergite devoid of shagreen; tergite II with fine shagreen which is coarser near the lateral and ventral margins; posterior margin of II with the usual row of hooks numbering about 80, the row interrupted near the midline; tergites III to VIII with a partially doubled row of tubercle spines, the row being slightly interrupted near the midline; posteriorly the spines on each segment decrease in number and progressively become more acutely tipped; segments VI to VII with 4 lateral flattened filaments which are about evenly spaced; segment VIII with 5 lateral filaments, 2 in the anterior half and 3 in the posterior half. Swim fin with a fringe of 72 filaments. Genital sacs with an acutely tipped terminal constriction; tergite IX with the usual bifurcate process.

The larva keys in Curry (1958: 431-433) to couplet 4. It may be distinguished from *sorex* (Townes) and *digitatus* Malloch by different features of the mandible and labial plate (cf. Figures 59, 60).

The pupa can be distinguished from all other species of this group by the distinctively different cephalic tubercles (cf. Figures 63, 64).

Figures 56-64. Chironomus (Cryptochironomus) ponderosus new species. 56. male genitalia; 57. details of inferior and superior appendage; 58. female genitalia; 59. larval labium; 60. mandible; 61. antenna; 62. maxilla; 63. cephalic tubercles of pupa, dorsal view; 64. cephalic tubercles of pupa, lateral view.

CHIRONOMUS (CRYPTOCHIRONOMUS) FULVUS Johannsen (Townes)

Chironomus fulvus Johannsen, 1905: 224, description of pupa and adult female. Townes (1945) reports the pupa to have probably been misidentified.

Chironomus sp. c Malloch, 1915a: 529, larva and pupa (fide, Townes, 1945).

Cryptochironomus fulvus (Johannsen); Townes, 1945: 98, adult male and female; synonomy.

Cryptochironomus fulvus (Johannsen); in part; Sublette, 1957: 389, ecology.

Tendipes (Cryptochironomus) fulvus (Johannsen); Dendy and Sublette, 1959: 516, generic position; adult male.

?*Cryptochironomus fulvus* (Johannsen); Beck and Beck, 1959: 93, adult distribution; phenology.

Tendipes (Cryptochironomus) fulvus (Johannsen); Sublette, 1960: 223, adult male and female (part).

Nec!*Chironomus (Cryptochironomus) fulvus* Johannsen, 1937b: 39 larva and pupa.

Nec!*Cryptochironomus fulvus* (Johannsen); Curry, 1958: 435, larva and pupa; ecology.

Nec! *Tendipes (Cryptochironomus) fulvus* (Johannsen); Darby, 1962: 162, description of larva and pupa; ecology.

Larva: This species was briefly described by Malloch (1915a: 529) as *Chironomus* species c. During the present study several larvae were reared, the adults of which agreed with the description given by Townes, 1945, and the specimens from the Hauber collection identified by Townes.

Head 0.38-0.40, mean 0.39 mm long (5) by 0.26-0.29, mean 0.27 mm. wide (2). Head capsule yellow except for tips of mandibles and labial plate. Labial plate (Fig. 65) very similar to that of other species of the *fulvus* group, most closely resembling that of *C. digitatus* (Malloch) (cf. Curry, 1958, figure 19). The antenna (Fig. 66) is similar to that figured by Malloch (1915, Pl. XXX, figure 2) but differs in the details of the last two segments. The mandibles (Fig. 67) are also similar to that shown by Curry (op. cit.) for *digitatus*. The premandibles (torma) are shown in Figure 68. The epipharyngeal area is indistinguishable from that of *digitatus* (cf. Curry, 1958, figure 1). Preanal papillae short, each with 6 to 7 pale terminal bristles. Anal prolegs with about 20 yellowish claws.

Pupa: Briefly described by Malloch (1915a) as *Chironomus* sp. c and keyed by Roback (1957c) as *Cryptochironomus* sp. 3.

The cephalic tubercles (dorsal view, Figs. 69 and 70; lateral view, Fig. 71) are distinctively different. There is some variation in this structure among different populations: it is construed as varietal. Exuviae dark yellowish-brown; length 5.18-8.18, mean 6.23 mm (5). Tergite I devoid of spines or shagreen, but with two large ventral tubercles beset with denticles, a feature apparently characteristic of the *fulvus* group. Tergite II with the usual row of posterior marginal spines interrupted for about the middle one-fourth of the row length; the row composed of about 48 yellowish curved spines. Tergites III to VII each with a posterior row of denticles, the rows progessively decreasing in size posteriorly. Immediately in front of the posterior rows of segments III to V is a row of 4 fine bristles on each side of the midline; on segments VI and VII there are only 2 bristles instead of 4. Tergite VIII has only a single bristle on each side of the midline at the posterior margin. Between the genital sacs is the usual bifurcate process typical of this group. Swim fin with the bristle fringe in a single layer anteriorly, the posterior part doubled dorso-ventrally. Number of fringe bristles 50-67, mean 60 (3).

Adult: *Chironomus fulvus* Johannsen was described from a female, the characteristics of which are insufficient for specific recognition, as they are for most members of this family. The male was first described by Malloch (1915a) but Townes (1945) reported Malloch's series to have been mixed. The description of the male by Townes (op. cit.) is then the first authoritative one. Townes synonomizes with *fulvus* Johannsen the following: *fulvus* Johannsen, Malloch (in part); *parvilamellatus* Malloch; and *mallochi* Kieffer (=*abbreviatus* Malloch, nec Kieffer). As it now stands Townes' interpretation of *fulvus* must be accepted as definitive with his illustration of the male genitalia serving in lieu of type specimen. I have examined adult males in the Hauber Collection determined by Townes and believe the material at hand is conspecific with it. However, the adults which I listed for California (1960) also agree with the Hauber specimens in every feature examined. Darby (1962), on the basis of adults determined by me, described a larva and pupa which is identical with that illustrated by Curry (1958) for *fulvus*. Thus at least two distinct larval and pupal types appear to exist under the name of *fulvus*. Further, I have reared specimens of three additional pupal types (to be described elsewhere), the adults of which are indistinguishable

from *fulvus* in Townes' key. Thus *fulvus* probably is a complex of closely related species which are best defined by pupal characteristics. Distinctive adult characteristics remain to be demonstrated.

The pupa questionably associated with the holotype female is undoubtedly a member of the *Harnischia* group of *Cryptochironomus* as was pointed out by Townes (op. cit.) and Darby (op. cit.).

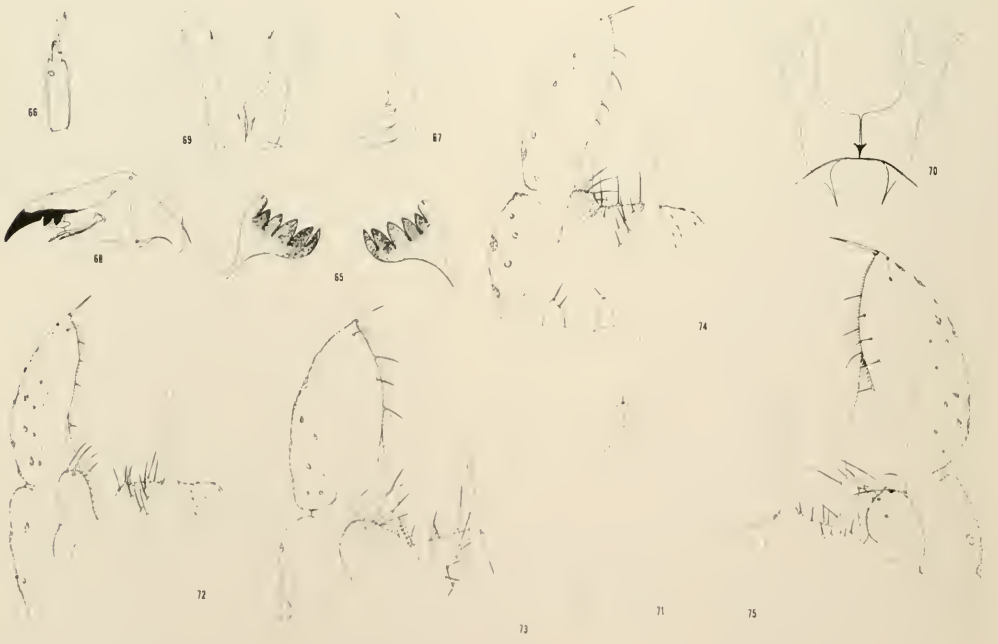
On the basis of Townes' synonomy of Malloch's *Chironomus* species c with *fulvus* I am taking it to represent the pupa of *fulvus*. With this reasoning Curry's and Darby's *fulvus* will need to be described as a new species.

The adult males before me agree well with the color description given by Townes (1945). The frontal tubercles are small and inconspicuous but clearly visible on a well mounted specimen. Postocular bristles in two rows; immediately behind the eyes is a straight row of large bristles; posterior to that is a smaller second row much more closely spaced. The hump at the end of the mesonotal median vitta is distinct. Dorsomedial and dorsolateral bristles long and erect, the latter in a partial double row. Prealar bristles 5; supra-alar bristles absent; posterior scutellar bristles large and erect, about 10, in a straight transverse row; anterior scutellar bristles about 6, smaller, in a strewn pattern.

Antennal and leg ratios, as well as size (wing length) are highly variable among different populations. In all instances, however, values overlap. Wing length 1.94-3.15, mean 2.39 mm (29); leg ratio 1.60-2.02, mean 1.78 (27); antennal ratio 2.75-3.35, mean 3.04 (20).

The genitalia are quite variable as to ratio of width to length of dististyle: ratio 2.00-3.30, mean 2.60 (34). Two principal types are apparent, a light bodied one as shown in Figure 72 and a heavier one shown in Figure 73. Intermediates are shown in Figures 74 and 75.

Material examined: One male, 8-VI-57; 1 male, 2-VII-57; 1 pupal exuvia, 23-VII-57; 1 male, 30-VII-57; 2 males, 6-VIII-57; 3 males, 13-VIII-57; 1 male, 10-IX-57; 1 male, 25-II-58; 1 male, 7-IV-58; 1 male, 5-V-58; 1 pupal exuvia, 10-VI-58; C.R.L. One pupal exuvia, 9-VI-51; 1 male, 29-VI-62; Uni-



Figures 65-75. Chironomus (Cryptochironomus) fulvus (Johannsen) Townes. 65. labial plate of larva; 66. antenna; 67. mandible; 68. premandible (torma); 69-70. cephalic tubercles, dorsal views; 71. cephalic tubercles, lateral view; 72. male genitalia; 73-75. variations of male genitalia.

versity of Oklahoma Biological Station. Two males, 29-IV-57; 2 males, 21-V-57; 2 males, 14-V-57; 1 male, 15-V-57; at light, Natchitoches, La. One male, 5-X-59; 1 male, 10-X-59; Sabine River at La.-Tex. line, west of Many, La. One male, 16-III-60; Bayou Pierre, 5 miles north of Natchitoches, La. One male, 25-VI-62; Forguson's Pond, west of Willis, Okla. One male, 16-VI-60; small stream 7 miles east of Liberty, Tex. One male, 20-VI-41; 2 males, 14-VII-41; 1 male, 23-VII-41; 1 male, 27-VII-41; 1 male, 2-V-42; 1 male, 22-V-42; Davenport, Iowa. One male, 18-VII-40, Lake Okobojii, Iowa, from Hauber Collection. Two males, 11-V-60; Sabine Bayou east of Clarence, La. One pupal exuvia, 24-IV-60; Trinity River, 13 miles west of Livingstone, Tex. One male, 21-VII-62; Lake Oberlin, Bryan Co., Okla. One male, 16-III-60; Old River, Natchitoches Parish, La.

CHIRONOMUS (CRYPTOCHIRONOMUS) NIGROVITTATUS Malloch

Chironomus nigrovittatus Malloch, 1915a: 456, adult.
Harnischia (Harnischia) nigrovittata (Malloch); Townes, 1945: 163, adult; generic position.
Harnischia (Harnischia) nigrovittata (Malloch); Sublette, 1957: 393, description of pupa; phenology.
Harnischia (Harnischia) nigrovittata (Malloch); Beck and Beck, 1959: 95, phenology and distribution of adult.
Tendipes (Cryptochironomus) nigrovittatus (Malloch); Sublette, 1960: 224, description of adults; generic position.

Males: Wing length 1.36-1.70, mean 1.59 mm (3); leg ratio 1.40-1.62, mean 1.53 (3); antennal ratio 2.03-2.22, mean 2.10 (4).

Material examined: Two males, 18-VI-57; 1 female, 27-VIII-57; 1 male, 30-IX-57; 6 males, 11-XI-57.

CHIRONOMUS (CRYPTOCHIRONOMUS) CARINATUS (Townes) new combination

Harnischia (Harnischia) carinata Townes, 1945: 158, adult.
Harnischia (Harnischia) carinata Townes; Sublette, 1957: 393, adult.
Harnischia (Harnischia) carinata Townes; Beck and Beck, 1959: 95, adult distribution; phenology.

Larva and pupa unknown.

Males: Wing length 1.36-1.80, mean 1.57 mm (4); leg ratio 2.00-2.07, mean 2.02 (3); antennal ratio 2.06-2.10, mean 2.05 (3).

Material examined: One male, 16-VII-57; 2 males, 27-VIII-57; 2 males, 10-IX-57; 2 males, 30-IX-57; 1 male, 7-X-57; 1 male, 14-X-57; C.R.L. One male, 3-VI-57; at light, Natchitoches, La. One male, 15-X-58; U.S.F.H.

CHIRONOMUS (CRYPTOCHIRONOMUS) CHAETOALA (Sublette) new combination

Tendipes (Cryptochironomus) chaetoala Sublette, 1960: 220, description of adult.
Tendipes (Cryptochironomus) chaetoala Sublette; Darby 1962: 35, 38, 50, 51, 59, 66, 73, 82, 83, 101, 160, 161, description of immature stages; ecology.

Males: Wing length 1.79-1.87, mean 1.85 mm (4); leg ratio 1.79-1.96, mean 1.88 (4); antennal ratio 2.14-2.50, mean 2.24 (4).

Material examined: One male, 29-III-54; 1 male, 11-IX-56; at light, Natchitoches, La. One male, 20-VIII-58; 5 males, 28-VIII-58; 4 males, 6-IX-58; 5 males, 12-IX-58; 4 males, 20-IX-58; 9 males, 27-IX-58; 1 male, 29-IX-58; 6 males, 4-X-58; 5 males, 15-X-58; U.S.F.H.

CHIRONOMUS (CRYPTOCHIRONOMUS) DIRECTUS (Dendy and Sublette) new combination

Tendipes (Cryptochironomus) directus Dendy and Sublette, 1959: 514, description of adult.

Material examined: In addition to the original type series from this locality, I have examined the following: Three males, 11-IX-56; 1 male, 27-VIII-57; 1 male, 17-IX-57; 2 males, 24-IX-57; 1 male, 30-IX-57; 1 male, 7-X-57; 3 males, 14-X-57; C.R.L. Two males, 6-IX-58; 3 males, 12-IX-58; 2 males, 20-IX-58; 7 males, 27-IX-58; 1 male, 15-X-58; 1 male, 29-X-58; 1 male, 6-XI-58; U.S.F.H.

CHIRONOMUS (CRYPTOCHIRONOMUS) EMORSUS (Townes) new combination

Harnischia (Harnischia) emorsa Townes, 1945: 161, description of adults.
Chironomus fulvus Johannsen, 1905: 224, description of pupa, misdetermined.
Chironomus (Limnochironomus) sp. Johannsen, 1938: (1937b) 44, description of pupa.
Harnischia (Harnischia) emorsa Townes; Beck and 1957c: 101, pupa, in key.
Harnischia (Harnischia) emorsa Townes; Roback, Beck, 1959: 95, adult.

Males: Wing length 1.46, 1.61 mm (2); leg ratio 2.14, 2.25 (2); antennal ratio 1.89, 2.24 (2).

An adult with an adherent pupal exuvia and a pupa with visible male genitalia collected during the study agree with the descriptions listed in Townes' synonomy given in parenthesis above, thus confirming his association.

Material examined: One male, 1 pupa, 6-VIII-57; 1 male, 10-VIII-57; C.R.L. One pupal exuvia, 20-X-55; Ch.L.

CHIRONOMUS (CRYPTOCHIRONOMUS) GALEATOR (Townes) new combination

Harnischia (Harnischia) galeator Townes, 1945: 170, description of adult male.

Harnischia (Harnischia) galeator Townes; Beck and Beck, 1959: 95, adult distribution and phenology.

Male: Wing length 1.62-1.75, mean 1.69 mm (4); leg ratio 1.70-2.34, mean 1.95 (4); antennal ratio 2.11-2.33, mean 2.22 (4).

Material examined: One male, 17-XI-55; Ch.L. Seventeen males, 27-VIII-57; 2 males, 3-IX-57; 2 males, 10-IX-57; 1 male, 30-IX-57; 4 males, 7-X-57; 1 male, 29-X-57; C.R.L. Two males, 2-III-57; 1 male, 29-IV-57; 1 male, 14-V-57; 1 male, 10-VII-57; at light, Natchitoches, La.

CHIRONOMUS (CRYPTOCHIRONOMUS) MONOCHROMUS van der Wulp

Chironomus unicolor van der Wulp, 1858: 5, description of adult.

Chironomus monochromus van der Wulp, 1874: 129 (new name for *unicolor* van der Wulp nec Walker, 1848).

Harnischia (Harnischia) monochromus (van der Wulp); Townes, 1945: 160, adult; generic position.

Harnischia (Harnischia) monochromus (van der Wulp); Sublette, 1957: 391, description of immature stages; ecology.

Harnischia (Harnischia) monochromus (van der Wulp); Beck and Beck, 1959: 95, distribution and phenology of adult.

Tendipes (Cryptochironomus) monochromus (van der Wulp); Dendy and Sublette, 1959: 516, generic position.

Tendipes (Cryptochironomus) monochromus (van der Wulp); Sublette, 1960: 223, adults.

Tendipes (Cryptochironomus) monochromus (van der Wulp); Darby, 1962: 38: 50, 53, 164, ecology; adult, in key.

Males: Wing length 1.49-1.94, mean 1.74 mm (4); leg ratio 1.50-1.80, mean 1.66 (4); antennal ratio 1.80-2.10, mean 1.97 (3).

Material examined: One male, 19-21-III-58; 1 male, 7-IV-58; 9 males, 21-IV-58; 2 males, 30-IV-58; 3 males, 5-V-58; 2 males, 12-V-58; 3 males, 6-VI-58; C.R.L. One male, 3-III-57; 1 male, 11-III-57; 1 male, 12-III-57; 1 male, 16-III-57; 1 male, 28-III-57; 4 males, 8-IV-57; 2 males, 9-IV-57; 3 males, 12-IV-57; 5 males, 16-IV-57; 3 males, 29-IV-57; 1 male, 6-V-57; 2 males, 14-V-57; at light, Natchitoches, La. One male, 20-IX-58; 1 male, 15-X-58; U.S.F.H.

CHIRONOMUS (CRYPTOCHIRONOMUS) EDWARSDI (Kruseman)

Chironomus (Chironomus) virescens Meigen; Edwards, 1929: 391, misidentification of *virescens* Meigen.

Tendipes (Parachironomus) edwardsi Kruseman, 1933: 194, new name for *virescens* Meigen of Edwards; adult male.

Harnischia (Harnischia) edwardsi (Kruseman); Townes, 1945: 167, adult.

Harnischia (Harnischia) edwardsi (Kruseman), Beck and Beck, 1959: 95, adult distribution and phenology.

Tendipes (Cryptochironomus edwardsi Kruseman; Sublette, 1960: 224, adult.

Larva: Described from exuviae.

Head length 0.34 mm; mandible length, 0.10 mm; head darkened on posterior gular region, tips of labial plate and mandibles; the latter slender, acutely tipped with basal teeth rather conspicuous, Figure 76. Labial plate, Figure 77; antenna, Figure 78; premandible (torma), Figure 79. The epipharyngeal area differs somewhat from that illustrated for *Pseduochironomus aix* (Figure 37). Setae I and II, which are in line with one another, are large, simple and attentuate; seta II is slightly the larger; seta III is very small and inconspicuous and is located anterior and medial to II; the lateral spinulae are apparently absent, as are the pecten eppiharyngis, the chaetae, and the squama platia; there are about 5 chaetulae basales on each side. There is a single jointed dorsal labral bristle.

Pupa: Total length 2.92 mm; exuviae length 3.38 mm, exuviae pale yellowish-brown. Respiratory organ with about 20 fine branches. Cephalic tubercles prominent, acutely tipped (Figure 80). Tergite II with the usual posterior row of recurved hooks, the row interrupted along the midline and with about 12 hooks in each half. Tergites III to V with a partially doubled row of tubercle-like spines; tergite VI with a small mace-like tubercle (Figure 81) on midline, which is beset with the low tubercle-like

spines of the preceding segments. Tergites VII and VIII devoid of spines. Posterolateral margin of segment VIII with a short attenuate spine, Figure 82. Swim fin with a fringe of 48 bristles.

Males: Wing length 1.39-1.70, mean 1.50 mm (4); leg ratio 1.80-2.00, mean 1.91 (4); antennal ratio 1.88-2.02, mean 1.97 (5).

Material examined: One male, 21-IV-57; 3 males, 23-VIII-57; 1 male, 13-VIII-57; 6 males, 20-VIII-57; 3 males, 27-VIII-57; 1 male, 3-IX-57; 4 males, 10-IX-57; 2 males, 24-IX-57; 4 males, 30-IX-57; 10 males, 7-X-57; 21 males, 14-X-57; 4 males, 21-X-57; 1 male, 29-X-57; 7 males, 4-XI-57; 2 males, 11-XI-57; 1 male, 5-V-58; 1 male, 4-VI-58; C.R.L. Two males, 21-X-59; 1 male, 11-XI-59; Many, La. Two males, 20-X-55; Ch.L.

GLYPTOTENDIPES (PHYTOTENDIPES) MERIDIONALIS Dendy and Sublette

Glyptotendipes (Phytotendipes) paripes (Edwards); Sublette, 1957: 391, description of larva and pupa; ecology; misidentification of *paripes* (Edwards).

Glyptotendipes (Phytotendipes) meridionalis Dendy and Sublette, 1959: 517, description of adult.

Glyptotendipes (Phytotendipes) meridionalis Dendy and Sublette; Beck, 1961: 126, distribtution; phenology.

The larva of *meridionalis* may be distinguished from that of *lobiferus,* the only other Nearctic species of this subgenus known in the larval stage, by the accessory tooth of the mandible which is simple in *meridionalis* and notched in *lobiferus,* and by the antenna the third segment of which is 0.60 as long as the second in *meridionalis* and 0.75 as long as *lobiferus.*

The pupa of *meridionalis* differs from that of *lobiferus* as follows (based on material before me):

	meridionalis	*lobiferus*
exuviae length	8.00 mm (7-8.5)	10.00 mm (9-11)
mean length times mean width of maces on abdominal 2nd segment	0.10 x 0.07 mm	0.16 x 0.10 mm
3rd segment	0.15 x 0.07 mm	0.22 x 0.12 mm
4th segment	0.17 x 0.08 mm	0.24 x 0.12 mm
5th segment	0.22 x 0.08 mm	0.31 x 0.14 mm
6th segment	0.32 x 0.12 mm	0.53 x 0.22 mm
Color of spines of abdominal maces	brown	yellowish
Mean number of spines on maces 2nd segment	7	8
3rd segment	7	8
4th segment	7	8
5th segment	6	9
6th segment	11	19
Number of caudo-lateral spines on segment 8	0-2	4-9

Material examined: One male, 12-IX-58; U.S.F.H. One male, 9-XI-56; North Shore of Red River, Grande Ecore, Natchitoches, La. Five males, 28-II-57; 1 male, 3-III-57; 1 male, 12-III-57; 3 males, 13-III-57; 3 males, 29-IV-57; 1 male, 3-V-57; 2 males, 6-V-57; 2 males, 14-V-57; 1 male, 15-V-57; 3 males, 21-V-57; 1 male, 3-VI-57; 3 males, 25-VI-57; 1 male, 12-IV-58; at light, Natchitoches, La. One male, 7-IX-56; 4 males, 11-IX-56; 2 males, 22-X-56; 1 male, 6-II-57; 1 female, 8-VI-57; 1 male, 18-VI-57; 1 male, 19-VII-57; 1 male, 30-VII-57; 1 male, 7-IX-57; 1 female, 17-IX-57; 1 male, 1-X-57; 4 males, 7-X-57; 3 males, 1 female, 14-X-57; 1 male, 4-XI-57; 1 male, 11-XI-57; 1 male, 26-II-58; 1 female, 1-III-58; 1 male, 9-III-58; 2 males, 19-21-III-58; 2 females, 7-IV-58; 1 male, 12-V-58; 7 males, 2 females, 4-VI-58; 6 males, 6-VI-58; 1 male, 10-VI-58; 2 males, 10-VII-58; C.R.L.

GLYPTOTENDIPES (PHYTOTENDIPES) LOBIFERUS (Say)

Chironomus lobiferus Say, 1823: 12, description of adult.

Glyptotendipes (Phytotendipes) lobiferus (Say); Townes, 1945: 142, description of adult; generic position.

Glyptotendipes lobiferus (Say); Judd, 1949: 9, phenology.

Glyptotendipes (Phytotendipes) lobiferus (Say); Berg, 1950: 92-94, description of larva and pupa; ecology.

Glyptotendipes lobiferus [(Say)]; Gerry, 1951: 141-144, ecology.

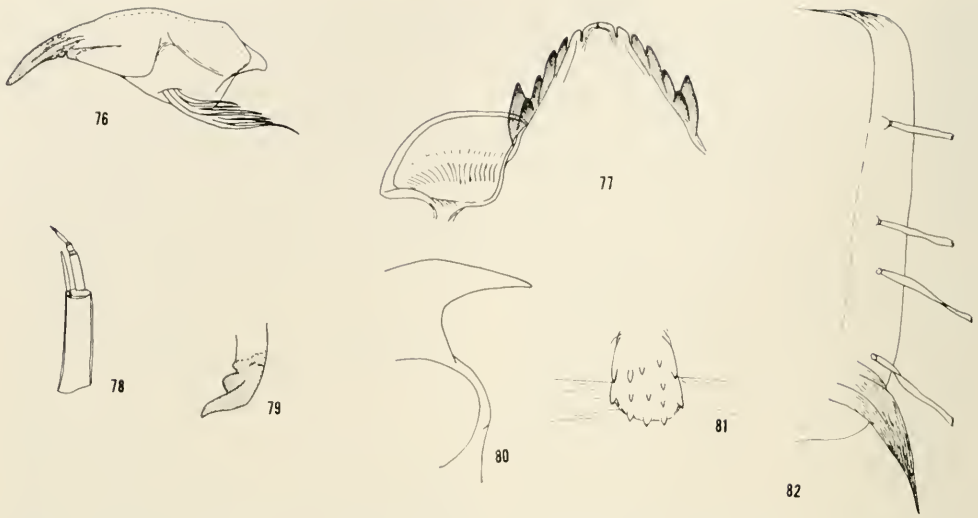
Glyptotendipes lobiferus (Say); Judd, 1953: 813, phenology.

Glyptotendipes lobiferus [(Say)]; Gerry, 1954: 148, ecology; control.

Glyptotendipes lobiferus (Say); Paine and Gaufin, 1956: 296, ecology.

Glyptotendipes (Phytotendipes) lobiferus (Say); Roback, 1957c: 123, larva and pupa, in key.

Glyptotendipes lobiferus (Say); Judd, 1957: 401, phenology.



Figures 76-82. Chironomus (Cryptochironomus) edwardsi (Kruseman). 76. larval mandible; 77. labial plate; 78. antenna; 79. premandible (torma); 80. cephalic tubercles of pupa; 81. chaetotaxy of tergite VI; 82. spine of posterolateral margin of Segment VIII.

Glyptotendipes (Phytotendipes) lobiferus (Say); Beck and Beck, 1959: 95, distribution and phenology of adult.
Glyptotendipes (Phytotendipes) lobiferus (Say); Dendy and Sublette, 1959: 518, adult, in table.
Glyptotendipes lobiferus (Say); Judd, 1960: 207, phenology.
Glyptotendipes (Phytotendipes) lobiferus (Say); Sublette, 1960: 225, adult.
Glyptotendipes lobiferus (Say); Judd, 1961: 96, phenology.
Glyptotendipes (Phytotendipes) lobiferus (Say); Darby, 1962: 38, 39, 47, 59, 68, 74, 89, 101, 114, 170-172; description of larva, pupa and adult; ecology.

Males: Wing length 3.38-4.05, mean 3.78 mm (5); leg ratio 1.40-1.66, mean 1.47 (5); antennal ratio 4.12-5.10, mean 4.68 (5); body length 7.40-8.00, mean 7.51 mm (6); Ta_2:Ta_3 1.21-1.31, mean 1.26 (5).

Material examined: One male, 23-VII-57; 1 female, 18-VII-57; 1 male, 6-VIII-57; 2 males, 17-IX-57; 1 female, 24-IX-57; 1 female, 3-X-57; 1 male, 14-X-57; 1 female, 1-III-58; 1 male, 1 female, 3-III-58; 1 male, 3-IV-58; 1 male, 7-IV-58; 1 male, 14-IV-58; 1 male, 21-IV-58; 2 males, 1 female, 12-V-58; 1 female, 19-V-58; 1 male, 19-VI-58; C.R.L. One male, 6-X-56, 1 male, 2-III-57; 1 male, 3-III-57; 1 male, 29-IV-57; 2 males, 14-V-57; 1 male, 15-V-57; 2 females, 28-VI-57; at light, Natchitoches, La. One male, 12-IX-58; 1 male, 27-IX-58; 1 male, 15-X-58; U.S.F.H.

PARALAUTERBORNIELLA ELACHISTA (Townes)

Apedilum elachistus Townes, 1945: 33, description of adult.
Apedilum elachistus Townes; Gerry, 1954: 146, ecology; control.
Apedilum elachistus Townes; Beck and Beck, 1959: 92, distribution and phenology of adults.
Paralauterborniella elachistus (Townes); Dendy and Sublette, 1959: 513, generic position.
nec!*Paralauterborniella elachistus* (Townes); Darby, 1962: 46, and following, description of larva, pupa and adult; ecology. I consider Darby's species to be a variety of *Paralauterborniella subcincta subcincta*.

Males: Wing length 1.22-1.56, mean 1.39 mm (4); leg ratio 1.29, 1.31 (2); antennal ratio 1.00-1.05, mean 1.03 (4).

Material examined: One male, 28-VII-57; 1 female, 13-VIII-57; C.R.L. One male, 20-VIII-58; 3 males, 28-VIII-58; 1 male, 12-IX-58; 1 male, 29-X-58; 1 male, 6-XI-58; 1 male, 27-XI-58; 1 male, 27-XI-59; U.S.F.H.

LAUTERBORNIELLA VARIPENNIS (Coquillett)

Chironomus varipennis Coquillett, 1902: 94, description of adult.
Lauterborniella varipennis (Coquillett); Townes, 1945: 21, description of adult.
Lauterborniella varipennis (Coquillett); Hauber, 1947: 459, description of larva and pupa; phenology; ecology.
Lauterborniella varipennis (Coquillett); Beck and Beck, 1959: 92, distribution and phenology of adult.

Males: Wing length 1.45-1.69, mean 1.59 mm (4); antennal ratio 1.35-1.66, mean 1.51 (4).

Material examined. Two females, 3-VII-57; 1 male, 30-VII-57; 2 males, 1 female, 6-VIII-57; 1 female, 20-VIII-57; C.R.L. One female, 28-VIII-58; 1 male, 6-IX-58; 3 males, 12-IX-58; 1 male, 20-IX-58; 1 male, 27-IX-58; U.S.F.H.

STENOCHIRONOMUS MACATEEI (Malloch)

Chironomus macateei Malloch, 1915b: 45, description of adult.

Stenochironomus macateei (Malloch); Townes, 1945: 89, adults.

Stenochironomus macateei (Malloch); Paine and Gaufin, 1956: 296, ecology.

Males: Wing length 1.67-1.85, mean 1.77 mm (3); leg ratio 1.13, 1.21 (2); antennal ratio 1.70-2.00, mean 1.83 (3).

Material examined: Four males, 1 female, 30-VII-57; light trap, Natchitoches, La.

PEDIONOMUS gen. nov.

Type species: **Pedionomus beckae** new species.

Male antenna composed of 13 segments; female with 5 (2 basal segments fused immovably together, thus considered as 1). Fork of the cubitus distinctly distal to r-m crossvein. R_1 parallel with R_{2+3} for most of length then slightly divergent at tip; distinctly separated. Wing membrane devoid of macrotricha but with conspicuous microtricha at 100 magnification. Pronotum narrowed dorsally, inferior to anterior projection of mesonotum. Dorsocentral and dorsolateral bristles conspicuous, in partial biserial rows. The dorsocentral bristles begin at the anterior margin of the mesoscutum and extend posteriorly to the conspicuous hump of the mesonotum. Anterior tibia with a projecting scale which bears, in addition to a terminal small spine, 2 conspicuous setae (Fig. 83). Middle and hind tibiae with combs that are contiguous or overlapping, not fused (middle tibial combs, Figure 84). The middle tibia has one long spine on the inner comb and none on the outer, while the hind tibia has a still longer spine on the outer but none on the inner comb; spines on both combs with slightly recurved tips. Pulvilli present, deeply pectinate but not bilobed as in *Polypedilum*. Eighth abdominal segment not basally constricted as is *Polypedilum*.

Male genitalia, Figure 85, similar to *Stictochironomus* and *Polypedilum* but lacking inner row of setae at apex of dististyle; basal part of superior appendage more elongate than in these genera.

Etymology. Dwelling on the plains.

PEDIONOMUS BECKAE new species

Holotype male: U.S.N.M. No. 66460. Reared from a larva collected on floating wood, Cane River Lake, Natchitoches Parish, Louisiana, 1-X-57, J.E.S.

Head and antennal pedicel yellowish-brown, concolorous with ground color of thorax; antennal flagellum, narrow vittae and sternopleuron darker brown. Postocular bristles in a single row, reaching a point level with dorsal extension of eyes. Frontal tubercles absent; palpi normal, proportions 7:15:15:25, clypeus with 20 bristles. Antennal ratio 2.31.

Pedicel of haltere pale; knob black; wing length 2.04 mm; venarum ratio 1.12; supraalar bristles absent; prealar bristles 6; dorsomedian bristles partially in 2 rows, long and erect; dorsolateral bristles partially in 2 long, erect rows; scutellum with a posterior row of 18 heavy bristles in straight, transverse row; anteriorly with 8 fine bristles in a slightly staggered row.

Leg proportions:

	F	Ti	Ta_1	2	3	4	5	Leg ratio
Foreleg	55	42	70	45	35	27	12	1.66
Middle leg	60	50	33	20	15	8	5	0.66
Hind leg	63	57	47	27	20	12	6	0.83

Wing hair fringe long and dark; squama with about 10 hairs. Wing membrane devoid of macrotricha but with conspicuous microtricha visible at 100 magnification. R_1 parallel with R_{2+3} to near tip where the two diverge slightly; tips distinctly separated. R_{4+5} terminates over M; fork of Cu distal to r-m crossvein.

Abdominal incisures pale; each tergite occupied by a broad dark brown fascia; abdomen thus with conspicuous vittate pattern.

Genitalia (Fig. 85) superficially resemble that of several species of *Polypedilum, Stictochironomus,* and *Tribelos* but differs in lacking an inner apical row of bristles on dististyle, by having abbreviate dististyles, and by the distinctively shaped superior ap-

pendage. The almost parallel-sided eighth abdominal segment is in strong contrast with the triangular shaped one of *Polypedilum*.

Allotype female: U.S.N.M. Reared from larva collected from floating wood, Cane River Lake, Natchitoches Parish, Louisiana, 1-X-57.

Similar to the male except for sexual differences and a generally darker coloration. Head and thorax dark cinnamon brown, the thoracic vittae slightly darker; abdomen fasciate, the dark bands broader than in the male. Clypeus with 23 bristles; palpi proportions 5:13:13:24.

Wing length 2.18 mm; venarum ratio 1.19; prealar bristles 5 (paratype female); scutellar bristles 15 (paratype female).

Leg proportions:

	F	Ti	Ta_1	2	3	4	5	Leg ratio
Foreleg	65	47	76	46	35	27	12	1.62
Middle leg	68	58	32	18	19	9	5	0.55
Hind leg	68	64	45	25	20	12	5	0.70

Genitalia, Figures 86 and 87. Spermathecae very pale but discernible; spherical, each 0.08 mm in diameter.

Larva: Described from exuviae. Head length 0.49 mm; mandible length 0.13 mm. Head yellowish except for tips of mandibles, labial plate and narrow occipital margin.

Labial plate, Figure 88; antenna 5 segmented, Figure 89; mandible, Figure 90.

Epipharyngeal apparatus similar to that illustrated for *Pseudochironomus aix* Townes (Figure 37). The pecten epipharyngis is composed of 3 palmate, contiguous plates; chaetulae basales about 7 in number, tips of at least 2 members finely pectinate; squama platia with about 21 fine teeth forming a comb on each side; seta I palmate, shorter than in *P. aix*, distally fringed; seta II long, curved and undissected; seta III as in *P. aix;* seta IV present as 2 small peg-like structures on each side; chaetae about 6 on each side, finely pectinate; spinulae low and inconspicuous, about 4 on each side. Torma (premandible) yellowish, not distally darkened; with 3 terminal teeth which are progressively reduced in size basally.

Preanal papillae each with 8 long, yellowish bristles; on the anterior face of each papilla is the usual small bristle; below each papilla is a long yellow bristle. Each anal proleg with about 15 yellow claws.

Pupal exuviae: Total length 4.97 mm. Thorax, 1st two abdominal segments, and caudal lobe infuscate, remainder of exuvia pale except for dark spines and spinulae and lateral margin markings.

Cephalic tubercles scarcely discernible on the frontal plate; each low, rounded tubercle with a fine bristle. Respiratory organs long and finely branched, each with apparently 3 main basal branches.

Abdominal tergites as follows: I, devoid of shagreen. II, along the lateral margins are 2 fine, pale bristles each side. In the anterior one-third of the segment is a broad band of black spines like those illustrated on segment IV (Figure 91); at the posterior margin is the usual row of recurved black hooks numbering 37. In the center of the tergite on either side of the midline is an oval patch of fine shagreen.

III to V, pattern of bristles, spines, spinulae and shagreen essentially identical (cf. Figure 91 for segment IV). Intersegmental membrane between segments IV and V with a band of black spines (Figure 91). Shagreen of segment III less contiguous along anterior margin.

VI, anterior band of black spines absent. In the center of the tergite on either side of the midline is an ovoid patch of fine shagreen; near the posterior margin on either side of the midline is a patch of 10 to 12 fine spinulae.

VII, completely devoid of spines and shagreen.

VIII, posterolateral margin shown in Figure 92. Swim fin with about 82 uniformly arranged lateral filaments.

Paratype males: Wing length 1.78-2.22, mean 2.04 mm (9); leg ratio 1.51-1.87, mean 1.70 (5); antennal ratio 2.04-2.52, mean 2.34 (5).

Paratypes: One male, 1 female, 3-VII-57; 1 male, 13-VII-57; 2 males, 18-VII-57; 1 female, 22-VII-57; 1 male, 13-VIII-57; 1 female, 20-VIII-57; 1 female, 10-IX-57; 1 male, 17-IX-57; 3 males, 3 females, 24-IX-57; 1 male, 1-X-57; 2 males, 14-X-57; C.R.L. One male, 21-V-57; 1 male, 3-VI-57; 5 males, 30-VII-57; at light, Natchitoches, La. One male, 30-X-59; Old River, Cypress, La. One male, 1 female, 24-X-57; below Chivary Dam near Clarence, La. One male, 23-XI-59; Bayou Pierre, 5 miles north of

Figures 83-92. Pedionomus beckae new species. 83. foretibial apex; 84. middle tibial combs; 85. male genitalia; 86. female genitalia; 87. variation of female genitalia; 88. labial plate of larva; 89. antenna of larva; 90. mandible; 91 chaetotaxy of tergite IV of pupa; 92. posterolateral margin of Segment VIII.

Natchitoches, La. One male, 23-VI-57; 1 male, 30-VI-57; Polk Co., Lakeland, Fla. One male, 20-IX-60; 2 males, 16-VI-61; Jackson Co., Fla. One male, 13-VII-56; 1 male, 29-IX-60; Gadsen Co., Fla., Chattahoochee. One male, 16-X-57; Glades Co., Moore Haven, Fla. One male, 17-IX-60; 2 males, 28-IX-60; 1 male, 15-X-60; Wewahitchka, Fla., Gulf Co. One male, 6-IX-57; Seminole Co., Geneva, Fla. One male, 3-VIII-57; Miami, Dade Co. One male, 8-XI-60; Indian River, Vero Beach, Fla. One male, 23-IX-60; 1 male, 4-X-60; Broward Co., Andytown, Fla. One male, 6-IX-57; Winter Park, Orange Co., Fla. One male, 16-IX-57; Nokomis, Sarasota, Fla. One male, 6-VII-57; Lake Worth, Palm Beach Co., Fla. One male, 9-VIII-57; Jacksonville Branch, Duval Co., Fla. Seven males, 8-V-62; Bayou George, Bay Co., Fla. Two males, 16-VI-60; Concho River Lake, San Angelo, Tex. One male, 14-VI-60; Lubbock, Tex. In the collections of U.S.N.M., C.N.C., A.N.S.P., I.N.H.S., Cornell University and Florida State Board of Health.

Pedionomus beckae, new genus and species, differs from *Polypedilum* by having the ninth tergite of the male subtruncate

rather than triangular in outline; the dististyle lacks long bristles; and the pulvilli are not bifid. It differs from *Stictochironomus* by having a conspicuous spine at the apex of the fore tibia and in details of the male genitalia.

The larva keys in Roback (1957c, pp. 96-98) to *Polypedilum*. It closely resembles the *fallax* group in having a labial plate with teeth of about equal length. It may be distinguished by the paralabial plates which are about 4 times as broad as long.

The pupa keys in Roback (loc. cit.) to *Tanytarsus* (part). This species does not fit well in his key to species of *Tanytarsus*. It can be distinguished from the species he described by the low rounded cephalic tubercle bearing a fine bristle.

I take pleasure in naming this species in honor of Mrs. Elisabeth Beck, Florida State Board of Health, who supplied the paratype material from Florida.

POLYPEDILUM (POLYPEDILUM) TRIGONUM Townes

Polypedilum (Polypedilum) trigonus Townes, 1945: 49, description of adult.
Polypedilum (Polypedilum) trigonus Townes; Hauber, 1947: 462, adult.
Polypedilum (Polypedilum) trigonus Townes; Dendy and Sublette, 1959: 513, adult.
Polypedilum (Polypedilum) trigonus Townes; Beck and Beck, 1959: 92, distribution; phenology of adult.

Males: Wing length 1.71-1.98, mean 1.83 mm (3); leg ratio 1.73 (1); antennal ratio 2.05-2.25, mean 2.13 (3).

Material examined: One male, 3-IX-57; 1 male, 17-IX-57; 1 male, 24-IX-57; 1 male, 30-IV-58; C.R.L.

POLYPEDILUM (POLYPEDILUM) ILLINOENSE (Malloch)

Chironomus illinoensis Malloch, 1915a: 471, description of adult.
Polypedilum (Polypedilum) illinoense (Malloch); Townes, 1945: 57, adult.
Polypedilum (Polypedilum) illinoense (Malloch); Hauber, 1947: 462, description of larva and pupa; ecology.
Polypedilum (Polypedilum) illinoense (Malloch); Berg, 1950: 91-92, description of larva and pupa; ecology.
Polypedilum (Polypedilum) illinoense (Malloch); Roback, 1953: 124, ecology.
Polypedilum illinoense (Malloch); Wurtz and Roback, 1955: 200, distribution; ecology.
Polypedilum (Polypedilum) illinoense (Malloch); Tebo, 1955: 97, ecology.
Polypedilum (Polypedilum) illinoense (Malloch); Paine and Gaufin, 1956: 296, ecology.
Polypedilum (Polypedilum) illinoense (Malloch); Sublette, 1957: 387, ecology; phenology.
Polypedilum (Polypedilum) illinoense (Malloch); Roback, 1957c: 117, description of larva and pupa.
Polypedilum (Polypedilum) illinoense (Malloch); Dendy and Sublette, 1959: 513, adult.
Polypedilum (Polypedilum) illinoense (Malloch); Beck and Beck; 1959: 93, distribution and phenology of adult.
Polypedilum (Polypedilum) illinoense (Malloch); Sublette, 1960: 207, adult.

Males: Wing length 1.67-2.34, mean 1.98 mm (3); leg ratio 1.57-1.80, mean 1.68 (3); antennal ratio 1.73-2.00, mean 1.91 (3).

Material examined: One male, 5-II-57; 1 male, 28-III-57; 1 male, 9-IV-57; 2 males, 6-V-57; 1 male, 14-V-57; 1 male, 21-V-57; 2 males, 3-VI-57; 1 male, 11-VII-57; 1 male, 13-VIII-57; 1 male, 1-XI-57; 1 male, 5-V-58; C.R.L.

POLYPEDILUM (POLYPEDILUM) DIGITIFER Townes

Polypedilum (Tripodura) digitifer Townes, 1945: 45, description of adult.
Polypedilum (Tripodura) digitifer Townes; Sublette, 1957: 386, description of larva and pupa; ecology; phenology.
Polypedilum (Tripodura) digitifer Townes; Beck and Beck, 1959: 92, distribution and phenology of adult.
Polypedilum (Polypedilum) digitifer Townes; Dendy and Sublette, 1959: 513, adults.
Polypedilum (Polypedilum) digitifer Townes; Sublette, 1960: 206, adults.
Polypedilum (Polypedilum) digitifer Townes; Darby, 1962: 38, 48, 49, 146, 150, ecology.

Males: Wing length 1.56-1.80, mean 1.69 mm (4); leg ratio 1.83-2.08, mean 1.94 (4); antennal ratio 1.54-2.00, mean 1.81 (4).

Material examined: Four males, 20-X-55; 3 females, 21-X-55; 1 male, 27-X-55; Ch.L. One male, 7-IX-56; 1 male, 5 females, 22-X-56; 1 male, 2 females, 10-XII-56; 2 males, 26-II-57; 1 male, 3-III-57; 1 male, 28-III-57; 3 males, 5-IX-57; 2 males, 8-IV-57; 1 male, 12-IV-57; 1 male, 14-IV-57; 4 males, 16-IV-57; 1 male, 29-IV-57; 1 female, 30-IV-57; 1 male, 6-V-57; 1 male, 14-V-57; 1 male, 21-V-57; 1 intersex, 30-V-57; 1 male, 11 females, 3 intersexes, 18-VI-57; 6 males, 26 females, 5 intersexes, 25-VI-57; 1 male, 28-VI-57; 2 females, 2-VII-57; 1 male, 10-VII-57; 1 female, 1 intersex, 13-VII-57; 5 males, 7 females, 15-VII-57; 2 females, 16-VII-57; 3 females, 18-VII-57; 3 males, 23-VII-57; 1 male, 6-VIII-57; 2 males, 20-VIII-57; 2 males, 2 females, 27-VIII-57;

3 females, 28-VIII-57; 1 female, 10-IX-57; 1 male, 7-IX-57; 1 female, 30-IX-57; 1 intersex, 3-X-57; 1 male, 5-X-57; 4 males, 21-X-57; 3 males, 1 female, 30-XI-57; 1 male, 12-V-58; 1 male, 10-VI-58; C.R.L. Two males, 21-III-54; 1 male, 3-III-57; 1 male, 10-III-57; 4 males, 12-III-57; 2 males, 13-III-57; 3 males, 16-III-57; 2 males, 28-III-57; 3 males, 5-IV-57; 1 male, 21-V-57; 1 male, 1 intersex, 3-VI-57; 2 males, 16-VII-57; at light, Natchitoches, La.

Tribe Tanytarsini

TANYTARSUS (CLADOTANYTARSUS) VIRDIVENTRIS Malloch

Tanytarsus virdiventris Malloch, 1915a: 491, description of adult. I have examined Malloch's type series.

Tanytarsus mancus Walker; Hauber, 1944: 456, description of pupa and adult, misidentification of *mancus* Walker. I have examined Hauber's material.

Calopsectra viridiventris (Malloch); Johannsen (in Johannsen and Townes), 1952: 26, adult, in key.

Tanytarsus (Cladotanytarsus) viridiventris Malloch; Dendy and Sublette, 1959: 513, adult.

Tanytarsus (Cladotanytarsus) viridiventris Malloch; Darby, 1962, 38, 55, 56, 59, 70, 74, 92, 93, 101, 110, 111, 172-179, description of larva, pupa and adult; ecology.

Males: Wing length 1.40-1.80, mean 1.61 mm (3); leg ratio 1.73-2.00, mean 1.88 (3); antennal ratio 1.21-1.39, mean 1.30 (3).

Material examined: Five males, 25-VI-57; 1 male, 4-XI-57; 1 male, 19-VI-58; C.R.L. One male, 12-VIII-58; 1 male, 20-VIII-58; 1 male, 28-VIII-58; 1 male, 4-X-58; U.S.F.H.

TANYTARSUS (TANYTARSUS) CONFUSUS Malloch

Tanytarsus confusus Malloch, 1915a: 490, description of adult. I have examined Malloch's type series.

Tanytarsus (Calopsectra) sp. B Hauber, 1944: 454. I have examined Hauber's material and it appears to belong here.

Calopsectra confusa (Malloch); Johannsen (in Johannsen and Townes), 1952: 26, adult, in key.

Calopsectra confusa (Malloch); Roback, 1956: 113-116, description of larva, pupa and adult; 1957c: 131-132, larva and pupa, in key.

Calopsectra neoflavellus (Malloch); Sublette, 1957: 385, description of larva and pupa; ecology; phenology; misidentification of *neoflavellus* Malloch.

Tanytarsus (Tanytarsus) confusus Malloch; Dendy and Sublette, 1959: 513, adult.

Males: Wing length 1.80-2.12, mean 1.90 mm (4); leg ratio 2.67-2.73 (2); antennal ratio 1.33-1.61, mean 1.42 (5).

Material examined: One male, 20-VIII-57; 1 male, 30-IX-57; 1 male, 7-X-57; C.R.L. Four males, 7-VIII-39; Lake Okoboji, Iowa, U. A. Hauber.

TANYTARSUS (TANYTARSUS) **DENDYI** new species

Tanytarsus ejuncidus Walker (?); Hauber, 1944: 455, description of pupa and adult, misidentification of *ejuncidus*.

Holotype male: U.S.N.M. No. 66461; collected in a tent trap, Cane River Lake, Natchitoches, La., 11-XI-57; B. R. Buckley.

Antennal pedicel, thoracic vittae, postnotum and sternopleuron blackish-brown; ground color of head, thorax and entire abdomen yellowish-green; antennal flagellum and legs infuscate; halteres pale; postoculars in a single staggered row; frontal tubercles present, 0.03 mm long; palpal proportions: 10:15:15:25; antennal ratio 1.44.

Wing length 2.07 mm; venarum ratio 1.11. No supra-alar bristles; dorsomedial and dorsolateral bristles in a single row; scutellum with about 6 erect bristles in a straight transverse row.

Combs of middle and hind tibiae well separated, both inner and outer on each with a spur. Pulvilli not visible at 100 magnification.

Leg proportions:

	F	Ti	Ta_1	2	3	4	5	Leg ratio
Foreleg	46	26	65	32	27	25	10	2.50
Middle leg	52	44	26	15	10	8	5	0.59
Hind leg	58	60	42	22	22	15	8	0.70

Wing membrane well haired on distal half; f-Cu distal to r-m.

Genitalia (Figure 93) very similar to *xanthus* new species, but differing in having appendage 1a less than half the length of the apex, and by having the group of bristles on the ninth tergite. Figure 94 shows a variant collected at the type locality.

Paratype males: Wing length 1.62-2.25; mean 1.87 mm (8); leg ratio 2.40-3.00, mean 2.60 (7); antennal ratio 1.21-1.76, mean 1.39 (7).

Paratypes: One male, 3-II-58; 1 male, 5-V-58; C.R.L. One male, 23-II-60; below Chivary Dam, Natchitoches Parish, La. One male, 16-III-57; at light, Natchitoches, La. Two males, 5-VI-56; 1 male, 6-VI-56; 4 males, 8-VI-56; 1 male, 15-XI-56; 1 male, 15-III-57; 1 male, 28-III-57; Auburn, Ala., J.S. Dendy. One male, 5-V-41; 1 male, 12-II-43; 2 males, 28-IV-43; 2 males, 25-V-43;

1 male, 5-VI-43; Davenport, Iowa. One male, 15-IV-42; 1 male, 12-II-43; Credit Island, Iowa. One male, 1-IV-42; 1 male, 10-IV-42; Duck Creek Park, Iowa. One male, 16-VI-60; Concho River Lake, San Angelo, Tex. In the collections of C.N.C., A.N.S.P., I.N.H.S., and Cornell University.

This species keys in Johannsen (in Johannsen and Townes, 1952, page 25) to *neoflavellus* Malloch; it may be distinguished by the distinctively different superior appendage of the male genitalia which in *neoflavellus* has a strong lateral tubercle. Also, the punctae of the anal point in *dendyi* n. sp. are in a single row; in *neoflavellus* they become multiple basally.

This species is named for Dr. J. S. Dendy, Auburn University, Auburn, Alabama, who contributed the paratype series from Alabama.

TANYTARSUS (TANYTARSUS) **XANTHUS** new species

Tanytarsus (Tanytarsus) neoflavellus Malloch; Dendy and Sublette, 1959: 613, adult. Misidentification of *neoflavellus* Malloch. This identification had been based on an examination of a specimen in the INHS Collection, determined by Malloch. A recent examination of the lectotype by the author has revealed Malloch's type series to be of one species and the named specimen (slide no. 3075) to be another species, described here as new.

Holotype male: U.S.N.M. No. 66462. Collected from the hatchery ponds at the U. S. Fish Hatchery, Natchitoches, Louisiana, 12-VIII-58; funnel trap, R. F. Tyler.

Head, thorax and abdomen pale yellow, the thorax slightly darker because of the wing musculature.

Eyes somewhat reniform, the dorsal extension rather short and broad. Frontal tubercles present, length, 0.041 mm. Palpal proportions, 10:21:22:40. Antennal ratio, 1.53. Postocular bristles long and erect, in a single row of about 16 bristles.

Pronotum considerably below the rounded, projecting apex of the mesonotum; pronotum halves slightly notched. Dorsolateral and dorsomedial bristles long and erect, in a single row, the latter slightly staggered at mesonotal apex. A single heavy prealar bristle present. Scutellum with 6 bristles.

Wing membrane well haired almost to base. R_{1+5} ends proximal to M and distal to Cu_1. Wing length, 1.69 mm.

Fore tarsus not bearded. Pulvilli absent; empodium finely dissected, almost as long as claws which are almost straight being curved slightly only near tip.

Leg proportions:

	F	Ti	Ta_1	2	3	4	5	Leg ratio
Foreleg	70	41	105	47	40	32	13	2.56
Middle leg	77	62	38	21	16	10	7	0.61
Hind leg	85	73	56	35	32	19	10	0.77

Both combs of middle and hind leg spurred; spurs of middle leg of unequal length; ratio, 15:10; longer spur curved near tip. Spurs of hind tibia almost equal in length; outer spur more strongly curved near tip than middle tibial spur.

Genitalia, Figures 98 and 99, with anal point sparsely and coarsely punctate; appendage 1a almost as long as apex of superior appendage; ninth tergite with bristles.

Female not associated.

Paratype males: Wing length 1.71-2.39, mean 2.07 mm (4); leg ratio 2.32-2.37, mean 2.35 (4); antennal ratio 1.32-1.46, mean 1.37 (5).

Paratypes: Louisiana: one male, 12-VIII-58; 1 male, 6-IX-58; 1 male, 12-IX-58; 2 males, 20-IX-58; 1 male, 27-IX-58; 2 males, 4-X-58; 2 males, 15-X-58; 1 male, 29-X-58; 5 males, 6-XI-58; 6 males, 4 pupal exuviae, 27-XI-58; 1 pupal exuvia, 12-XII-58; 1 pupal exuvia, 10-I-59; 1 male, 15-I-59; 2 males, 25-I-59; 8 males, 5-II-59; 2 males, 7-II-59; 1 male, 9-II-59; 10 males, 15-II-59; U.S.F.H. One male, 8-IV-57; 2 males, 9-IV-57; 1 male, 28-VI-57; at light, Natchitoches, La. Illinois: one male, Peoria, Ill., 22-X-14, slide 3075 (In I.N.H.S. sub *neoflavellus* Malloch; determined J. R. Malloch).

Larva: Described from exuvia of reared male.

Head capsule pale except for the yellowish mandibular tips, labial plate and narrow occipital margin. Head length 0.40 mm. Mandible (Fig. 95) 0.12 mm long. Antenna (Fig. 96) 0.20 mm long; basal tubercle without a spur. Epipharyngeal area similar to other Chironominae; labial plate, Figure 97; pecten epipharyngis composed of 3 digitate blades; chaetulae basales finely pectinate distally, apparently 5 on each side; torma (premandible) gently curved distally, yellowish at tip, somewhat obscured on the mount before me so that bifurcation not visible; 5 long curved filiform chaetae on each side; squama platia with about 24 exceedingly fine teeth: seta I rather closely spaced together, coarsely pectinate; seta II

anterior to I and directly in line with it, long curved filiform seta reaching posteriorly to the squama platia; seta III minute, anterior to II and in line with it; spinulae somewhat obscured; dorsal labral bristles not evident.

Preanal papillae short, each bearing 8 conspicuous long blackened bristles. Posterior prolegs with 14 hooked yellowish claws.

The larva may be distinguished from related Nearctic species by the paralabial plates lying close together at the midline; the antennal tubercle lacking a spine; and the petiole of the Lauterborn organs being about as long as the last 3 antennal segments.

Pupa: Described from exuviae of reared males and from exuviae found in funnel traps in which adult males were taken.

Exuviae length 5.18 mm; cephalic tubercles, respiratory organs and abdominal chaetotaxy as illustrated by Roback (1957c) for *neoflavellus;* comb of segment VIII similar to that figured by Roback (op. cit.) but more spinose (5-10 large marginal spines; about 20-25 smaller disc spines); swim fin with a fringe of 39-40 flattened bristles on either side; disc finely shagreened.

Paratypes in the collections of C.N.C., A.N.S.P., I.N.H.S. and Cornell University.

TANYTARSUS (TANYTARSUS) NEOFLAVELLUS Malloch

Tanytarsus neoflavellus Malloch, 1915: 489, description of adult.

Tanytarsus neoflavellus Malloch; Boesel, 1940: 19, distribution and phenology.

Calopsectra neoflavella (Malloch); Johannsen (in Johannsen and Townes), 1952: 26, adult, in key.

Tanytarsus neoflavellus Malloch; Hauber, 1944: 455.

Nec! *Tanytarsus (Tanytarsus) neoflavellus* Malloch; Dendy and Sublette, 1959: 513, adult, misidentification.

Nec! *Calopsectra neoflavellus* (Malloch) Sublette, 1957: 385, misidentification.

Males: Wing length 1.67-2.25, mean 1.94 mm (5); leg ratio 2.56-3.33, mean 2.93 (3); antennal ratio 1.20-1.44, mean 1.30 (5).

Material examined: One male, 11-VI-57; 4 males, 18-VI-57; 3 males, 25-VI-57; 1 male, 15-VII-57; 3 males, 23-VII-57; 1 male, 24-IX-57; 1 male, 7-X-57; 1 male, 11-XI-57; 1 male, 5-V-58; 1 male, 10-VI-58; C.R.L. Five males, 16-III-57; 1 male, 8-IV-57; 1 male, 29-IV-57; at light, Natchitoches, La. One male, 6-XI-58; U.S.F.H. One male, 6-VI-56; 2 males, 8-VI-56; 1 male, 28-III-57; 1 male, 8-IV-57; Auburn, Ala. One male, 8-VIII-39; 5 males, 7/8-VIII-39; 2 males, 6-VIII-49; Lake Okoboji, Iowa. One male, 2-IX-62; Stratford, Conn.

This species resembles *xanthus* new species as well as *dendyi* new species. It differs significantly in genitalia characteristics. The tubercle on the superior appendage and the details of the anal point are distinctive.

TANYTARSUS (TANYTARSUS) **RECENS** new species

Holotype male: U.S.N.M. No. 66463. Collected from Cane River Lake, Natchitoches, Louisiana, 12-V-58, B. R. Buckley.

Head, thorax and abdomen pale stramineous; frontal tubercles small, conical, length 0.02 mm; antennal ratio 1.09. Palpal proportions 7:17:19:30.

Wing length 1.62 mm; one prealar bristle; halteres pale.

Combs of middle and hind legs separated; without spurs. Tip of legs obscured or missing so pulvilli not observed.

Leg proportions:

	F	Ti	Ta_1	2	3	4	5	Leg ratio
Foreleg	75	48	108	–	–	–	–	2.25
Middle leg	80	–	–	–	–	–	–	–
Hind leg	95	85	–	–	–	–	–	–

Wing membrane well haired.

The genitalia, Figure 100, are very similar to *quadratus* new species but with the following differences: appendage 1a evenly attenuate, not swollen near center; anal point with the basal ornamentation closed below (basally); tip of anal point more rounded; appendage 2 (inferior appendage) strongly capitate with 4 to 5 posteriorly directed bristles; appendage 2a with long terminal lamellae; ninth tergite with only 2 rather inconspicuous bristles.

This species is very similar to *varela* (Roback) (cf. Roback, 1957c, page 128, fig. 455) but if his specimen is accurately figurged this is a distinct new species.

TANYTARSUS (TANYTARSUS) **BUCKLEYI** new species

Holotype male: U.S.N.M. No. 66464. Collected from Cane River Lake, Natchitoches Parish, Louisiana, 17-IX-57, B. R. Buckley.

Frontal tubercles small, cylindrical; length

0.03 mm; palpal proportions 8:15:19:28. Antennal ratio 0.96.

Ground color of head and thorax yellowish; antennal pedicels, pronotum, mesonotal vittae, postnotum and sternopleuron cinnamon brown; halteres pale. Wing length 1.36 mm. Prealar bristles 1; dorsolateral and dorsomedial bristles in one row, large and erect; scutellar bristles 6, large and erect.

Except for the coxae the legs are pale; forelegs slightly darker; tarsal beard absent. Tibial combs of middle and hind legs well separated; those of the hind leg each with a spur; those of middle leg with a spur only on the inner comb. Pulvilli not visible at 100 magnification.

Leg proportions:

	F	Ti	Ta_1	2	3	4	5	Leg ratio
Foreleg	60	34	67	38	30	20	10	1.97
Middle leg	60	48	26	15	10	6	5	0.54
Hind leg	68	63	40	25	22	14	10	0.63

Wing membrane sparsely haired only on distal one-sixth; R_{1+5} terminates proximal to M and distal to Cu_1.

Abdomen greenish-yellow. Genitalia, Figure 101.

Paratype males: Wing length 1.19-1.80, mean 1.47 mm (5); leg ratio 1.87-2.10, mean 1.96 (3); antennal ratio 0.90-1.21, mean 1.07 (4).

Paratypes: One male, 13-VII-57; 1 male, 20-VIII-57; 2 males, 3-IX-57; 2 males, 30-IX-57; 1 male, 14-X-57; 2 males, 11-XI-57; 1 male, 9-XII-57; 1 male, 16-XII-57; 4 males, 23-XII-57; C.R.L. In the collections of C.N.C., A.N.S.P.

This species keys to *pusio* (Meigen) in Johannsen's key (in Johannsen and Townes, 1952, page 26). I have examined Johannsen's material at Cornell University and the species which he identified as *pusio* Meigen is totally different from *buckleyi* new species. Further, his material does not agree with the scanty description of *pusio* in European literature. *Pusio* probably does not occur in the Nearctic region. *Tanytarsus (Tanytarsus) buckleyi* new species is very similar to *glabrescens* Edwards, a Palaearctic species, but appears to differ in details of genitalic structure (cf. Edwards, 1929, figure 15f; Brundin, 1947, figure 112).

This species is named in honor of Burton R. Buckley, Natchitoches, Louisiana, who collected the specimen designated here as holotype.

TANYTARSUS (TANYTARSUS) **QUADRATUS** new species

Holotype male: U.S.N.M. No. 66466. Collected from Cane River Lake, Natchitoches Parish, Louisiana, 2-III-58, funnel trap, B. R. Buckley.

Frontal tubercles small, cylindrical, length 0.25 mm; antennal ratio 1.16. Palpal proportions 5:13:15:23.

Ground color yellowish; antennal pedicels, pronotum, mesonotal vittae, sternopleuron and postnotum dark cinnamon brown. Scutellum infuscate. Mesothorax with a distinct hump; halteres pale. Wing length 1.72 mm. Prealar bristles 2; dorsolateral and dorsomedial bristles in one row; scutellar bristles 8, large and erect; in a straight, transverse row.

Legs pale; posterior 4 tibial combs small, well separated, without spurs; forelegs not bearded. Pulvilli not visible at 100 magnification.

Leg proportions:

	F	Ti	Ta_1	2	3	4	5	Leg ratio
Foreleg	85	63	86	50	40	27	13	1.36
Middle leg	90	72	45	25	20	7	7	0.63
Hind leg	95	95	62	40	25	15	15	0.65

Wing membrane well haired almost to wing base.

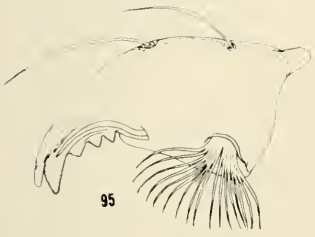
Abdomen with yellowish ground color, each tergite almost completely covered by a brown band, thus giving abdomen vittate appearance.

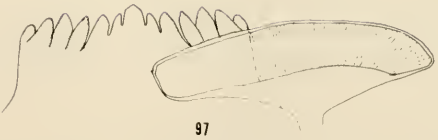
Genitalia, Figure 106, very similar to *dissimilis* Johannsen and *recens* new species.

Paratype males: Wing length 1.28-1.99, mean 1.59 mm (5); leg ratio 1.31, 1.34 (2); antennal ratio 1.05-1.26, mean 1.12 (3).

Paratypes: One male 27-VIII-57; 1 male, 3-II-58; 1 male, 22-II-58; 1 male, 2-III-58; 3 males, 12-V-58; C.R.L. In the collections of C.N.C., A.N.S.P.

This species runs in Johannsen's key (in Johannsen and Townes, 1952, pages 25, 26) to *dissimilis* Johannsen. It may be differentiated from that species by having a more setose ninth tergite, a shorter more quadrate anal point, and by differently shaped appendages 1a and 2a. It differs from *recens* new species in several features as noted under that species.





Figures 93-94. Tanytarsus (Tanytarsus) dendyi new species. 93. male genitalia; 94. variation of male genitalia. **Figures 95-99. Tanytarsus (Tanytarsus) xanthus new species.** 95. larval mandible; 96. antenna; 97. labial plate; 98. male genitalia; 99. details of appendage-2a. **Figure 100. Tanytarsus (Tanytarsus) recens new species.** 100. male genitalia. **Figure 101. Tanytarsus (Tanytarsus) buckleyi new species.** 101. male genitalia.

TANYTARSUS (TANYTARSUS)
ALLICIS new species

Holotype male: U.S.N.M. No. 66465; U. S. Fish Hatchery, Natchitoches, Louisiana, 29-X-58, R. F. Tyler.

Antennal pedicel, thoracic vittae, postnotum and mesosternum dark brown; ground color of head, thorax and abdomen stramineous; legs, antennal flagellum and halteres scarcely darkened. Antennal ratio 1.00. Frontal tubercles small, conical; length 0.02 mm. Palpal proportions 6:15:19:30.

Wing length 1.49 mm. Dorsomedial and dorsolateral bristles in one row, erect, scutellum with 5 long erect bristles.

Fore tarsus not bearded; middle tibial combs with a single spur; hind tibiae with a spur on each comb. Pulvilli not visible at 100 magnification.

Leg proportions:

	F	Ti	Ta_1	2	3	4	5	Leg ratio
Foreleg	66	35	58	42	32	25	12	1.66
Middle leg	70	56	33	17	11	8	7	0.59
Hind leg	75	75	50	28	25	18	10	0.67

Wing membrane with macrotrichia on distal third only; longitudinal veins with macrotrichia almost the entire length.

Genitalia, Figure 102, mounting variant, Figure 103, very similar to *buckleyi* new species but differing in the narrower anal point, and the strikingly different appendage 2a; appendage 1a is also different.

Paratype males: Wing length 1.26-1.58, mean 1.40 mm (3); leg ratio 2.09 (1); antennal ratio 0.91-1.06, mean 0.97 (3)

Paratypes: Two males, 27-IX-58; 1 male, 6-XI-58; U.S.F.H. One male, 16-X-57; San Jose Creek, Many, La. One male, 13-III-57; at light, Natchitoches, La. In the collections of C.N.C., A.N.S.P.

This species is very similar to the palearctic species, *Tanytarsus (Tanytarsus) recurvatus* Brundin (cf. Brundin, 1947, page 75, figure 113). It differs only in slight features of appendages 1a and 2a. Among the Nearctic fauna it most closely resembles *buckleyi* new species but is differentiated as was described under that species.

This species was reared from larvae collected in aquatic vegetation.

Larva: Exuviae not recovered.

Pupa: Described from exuvia of reared male. Exuvia approximately 2.48 mm long, yellowish-brown with blackish-brown lateral longitudinal markings. Respiratory organ a simple tubular filament, approximately 0.32 mm long. Abdominal chaetotaxy shown diagramatically in Figure 104. Posterolateral comb of segment VIII as in Figure 105. Swim fin with about 18 to 20 filaments.

The pupa keys in Roback (1957c, page 132) to couplet 7. It may be distinguished from the species designated by Roback as *Calopsectra* (i.e., *Tanytarsus*) *neoflavella?* (Malloch) by the shorter respiratory organs (0.32 mm versus 0.53 mm); by a different pattern of chaetotaxy (cf. Figure 104 and Roback's figure 516) and by different caudo-lateral combs (cf. Figure 105 and Roback's figure 486).

TANYTARSUS (TANYTARSUS)
LIMNETICUS new species

Holotype male: U.S.N.M. No. 66467. Collected from the U. S. Fish Hatchery, Natchitoches, Louisiana, 20-VIII-58, tent trap, R. F. Tyler.

Postocular bristles in one row, beginning medial to dorsal extension of eyes; dorsal extension of eyes rather broad, extension having 4 to 5 facets in a transverse row; minute but distinct frontal tubercles, length 0.02 mm (paratype); palpal proportions 5:10:10:22; antennal ratio 1.44. Head, thorax and abdomen pale; vittae, sternopleuron and postnotum pale ocherous. Wing length 1.71 mm; venarum ratio 1.06. Prealar bristles 3; dorsomedian bristles long and erect; dorsolateral bristles long, erect, in one row; about 14 scutellar bristles in a transverse row.

Legs with tibial combs separate, each comb with a spur; forelegs darkened beyond tibia. Small pulvilli visible at 100 magnification.

Leg proportions:

	F	Ti	Ta_1	2	3	4	5	Leg ratio
Foreleg	55	28	70	32	–	–	–	2.50
Middle leg	50	40	26	16	13	8	6	0.65
Hind leg	57	52	35	22	17	10	7	0.67

Wings with R_{4+5} terminating distal to M; f-Cu slightly distal to r-m; wing membrane well haired; C and R with long conspicuous pale hairs.

Genitalia, Figures 108, 109, 110.

Paratype males: Wing length 1.67-2.03, mean 1.83 mm (3); leg ratio 2.25-2.50, mean 2.37 (3); antennal ratio 1.40-1.50, mean 1.45 (3).

Figures 102-105. Tanytarsus (Tanytarsus) allicis new species. 102. male genitalia; 103. variation of male genitalia; 104. pupal chaetotaxy; 105. posterolateral comb of Segment VIII. **Figures 106-107. Tanytarsus (Tanytarsus) quadratus new species.** 106. male genitalia; 107. variation of ninth tergite. **Figures 108-110. Tanytarsus (Tanytarsus) limneticus new species.** 108. male genitalia; 109. superior appendage; 110. appendage 2a.

Paratypes: Five males, 12-VIII-58; 3 males, 20-VIII-58; 1 male, 28-VIII-58; 2 males, 6-IX-58; 7 males, 12-IX-58; 3 males, 20-IX-58; 2 males, 15-X-58; U.S.F.H. In the collections of A.N.S.P., I.N.H.S., C.N.C., and Cornell University.

This species may be distinguished from the remainder of the Nearctic fauna by its distinctive male genitalia. It keys to *neoflavellus* Malloch in Johannsen (Johannsen and Townes, 1952, pages 25, 26) but the punctate anal point of that species is totally different.

Summary

1. Fifty-seven species of chironomid midges are reported from lentic situations in Louisiana.

2. Of the species described, one is a new

genus and fourteen are species new to science.

3. The immature stages of twelve species are described.

4. Five new taxonomic combinations are given.

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ABSTRACT

SUBLETTE, JAMES E. (Eastern New Mexico U., Portales). Chironomidae (Diptera) of Louisiana I. Systematics and immature stages of some lentic chironomids of West-Central Louisiana. Tulane Stud. Zool.

Fifty-seven species of chironomid midges are reported, including the following fourteen new species and one new genus: *Ablabesmyia* **rhamphe,** *Cricotopus* **remus, lebetis,** *Chironomus (Chironomus)* **natchitocheae,** *(Dicrotendipes)* **incurvus,** *(Cryptochironomus)* **ponderosus, Pedionomus beckae,** *Tanytarsus* **dendyi, xanthus, recens, quadratus, buckleyi, allicis, limneticus.** The immature stages of twelve species are described. Five new combinations are given: *Ablabesmyia aequifasciata (Pentaneura (Ablabesmyia) aequifasciata* Dendy and Sublette), *Chironomus (Cryptochironomus) chaetoala (Tendipes (Cryptochironomus) chaetoala* Sublette), *Chironomus (Cryptochironomus) directus (Tendipes (Cryptochironomus) directus* Dendy and Sublette), *Chironomus (Cryptochironomus) emorsus (Harnischia (Harnischia) emorsa* Townes), *Chironomus (Cryptochironomus) galeator (Harnischia (Harnischia) galeator* Townes).

CHIRONOMIDAE (DIPTERA) OF LOUISIANA
II. THE LIMNOLOGY OF THE UPPER PART OF CANE RIVER LAKE, NATCHITOCHES PARISH, LOUISIANA, WITH PARTICULAR REFERENCE TO THE EMERGENCE OF CHIRONOMIDAE[1]

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Much of what is known about aquatic insect populations has been learned from bottom faunal studies using conventional bottom samplers. Quantitative and qualitative data have been secured in this manner but investigators have experienced difficulty in making positive identifications of the immature forms taken. Consequently, many limnologists have not attempted to make identifications below the family level, or at most to genus. This is particularly true for the Family Chironomidae which comprises one of the major components of the benthos. The problem of generic and specific determination is considerably reduced when tent and funnel traps are used since the adults which are taken in these traps can be more positively identified.

Recent reviews of the literature concerning tent and funnel traps for capturing emerging adults of aquatic insects have been made by Wohlschlag (1950), Jonásson (1954), and Guyer and Hutson (1955). In addition, Sublette and Dendy (1959), and Buscemi (1961) have described modifications of trapping devices.

In view of the difficulty encountered in making positive identification of larval midges, and the scarcity of studies on lakes in southern United States, this research was done to secure quantitative and qualitative data on the benthic organisms, particularly the Chironomidae, through conventional collections made from larval populations and from samples of adults taken by tent and funnel traps.

[1] This paper represents the greater portion of a thesis submitted by the senior author to the faculty of the Graduate School of Northwestern State College, Natchitoches, Louisiana, in partial fulfillment of the requirements for the degree of Master of Science.

Appreciation is expressed to Mary Smith Sublette for the preparation of genitalia mounts from pinned specimens and to Judith Jones Buckley for assistance in making the graphs.

History and Physiography of Cane River Lake

At the time of settlement by European immigrants of the lower Red River Valley, the river and surrounding flood plain were in a unique stage of development. For reasons only partially understood, tremendous numbers of logs, much debris, and silt choked the stream. This resulted in the formation of what was locally referred to as the "Great Raft." The damming action of the silt-laden log jams or "raft" caused the river to spill over into the back water swamps which are so characteristic of agrading mature river systems. This produced a series of "braided" channels and connecting shallow lakes (cf. Hutchinson, 1957, page 115). According to John Sibley, 1808, "An account of the Red River and country adjacent", *American Register*, Volume IV, fide Guardia (1927), there were four channels in the vicinity of the town of Natchitoches. These streams were, from east to west: Rigolets du Bon Dieu (now the main channel of Red River). Atoho (now Little River), Cane River (now Cane River Lake, an impoundment) and False River (now Old River). At his writing, Cane River was the boat channel. False River was navigable but had low banks. The Rigolets du Bon Dieu was the smallest of the four, but significantly (as it was later to steal the main channel) it was the swiftest. At the time of Sibley's report the Rigolets was just becoming navigable (Guardia, 1927). Over a period of a few years (the time is contro-

versial, but probably about 1830-1840) the Rigolets du Bon Dieu channel degraded as a result of successive high water periods and captured the major part of the water flow below Grand Ecore (four miles east of Natchitoches). This left Cane River as a flood water divergence channel navigable by shallow draft boats only during time of high water. During summer months the stream dried up to small stagnant pools. In the spring of 1916 (fide, The Golden Jubilee Issue, *Natchitoches Times,* 1953) two earthen dams were constructed on the channel, one at the upper end northeast of the city of Natchitoches and one located about two and one-half miles northwest of Derry, Louisiana, thus forming Cane River Lake.

The origin of the lake is evidenced by its narrowness and great length, the meandering path it takes through the parish, its regular shoreline and bottom contours, and the many remnants of sandbars. In addition, precipitous slopes forming the shore of much of the lake and the existence of terraces some distance away indicate its stream origin.

Throughout its length the lake is bordered by rich farm land. Consequently, the chief supply of water is run-off from cultivated fields. The main axis of the lake lies northwest-southeast.

The following morphometric features were listed by Geagan and Allen (1961): maximum length, 34.5 miles (55.5 km); mean width, 250 feet (76.2 meters); surface area, 1,044 acres (423.5 hectares); mean depth, 11.5 feet (3.4 meters); maximum depth near the spillway, 25.0 feet (7.6 meters).

Description of the Study Site

Samples taken at irregular intervals and sites during a preliminary survey of Cane River Lake from February 5, 1957, to July 12, 1957, showed the bottom contours and shoreline to be fairly uniform in the upper part of the lake. This survey was made while the junior author was conducting a research program subsidized by a National Institutes of Health research grant, RG-4594. Water samples taken at several sites in the upper end of the lake did not differ markedly from each other in physico-chemical characteristics.

Beginning in June, 1957, a program of seasonal study of the lake was begun at a site approximately one and one-half miles above the "new bridge" (bridge at Church Street crossing) located in downtown Natchitoches, and approximately two and one-fourth miles below the upper dam. In this report only the results obtained during the seasonal study are presented. Since the water quality and bottom features were found to be very similar in the several areas in the upper part of the lake only one transect was used for the seasonal study.

A three-quarter mile stretch of the lake on which the transect site was located lies in a northeast-southwesterly direction. The shoreline is quite regular, the eastern side being less precipitous than the western. The soil on the eastern side is Yahola Sandy Loam and on the western side is Yahola Clay. A few scattered willows, *Salix nigra* Marsh, are located along the shore above and below the sample site. The lake has a well-developed zone of emergent vegetation composed principally of alligator weed, *Alternanthera philoxeroides* (Mart.) Standl., and cutgrass, *Zizaniopsis miliacea* (Michx.) Doll and Asch.

The bottom contours of the seasonal sampling site were very regular, with each lying closely parallel to the shoreline. The one meter contour was located about four meters out from the shore and the two meter contour was about six meters beyond the first. The width of the lake at this point was forty-one meters and the maximum depth 2.8 meters.

Materials and Methods

Collection of adults. Samples of emerging adults were obtained at approximately weekly intervals from June, 1957, to July, 1958, using the traps and techniques described by Sublette and Dendy (1959). Two funnel traps were set on the bottom within each contour zone. Those set within the zero to one meter zone were located in a small cove formed by the outgrowth of alligator weeds. A conical tent trap was suspended over a bed of alligator weeds about fifty feet from the funnel traps. Except for three attempts to evaluate diel periodicity, the traps were lifted at the end of a twenty-four hour period. At the time of trap setting the temperature of each half meter depth of water was taken.

The flasks containing the insects were removed to the laboratory where adult chi-

ronomids which had been "wet down" and the exuviae were separated from the other forms and preserved in 70 per cent ethyl alcohol. A slide was later prepared of each adult and exuvia. Dry specimens were pinned on minuten nadeln. Insects other than the Chironomidae were preserved in 70 per cent alcohol and stored.

Collection of larvae. Bottom samples were taken with a six inch Ekman-Birge dredge at approximately monthly intervals. From three to five dredgings were taken at random within each meter contour. All sampling was done during daylight hours. Samples were washed in the field using a screen with 25 meshes per inch, then preserved in 10 per cent formalin. In the laboratory the organisms were removed from the debris, preserved in 70 per cent alcohol, and subsequently separated, counted, and measured volumetrically using Anderson and Hooper's (1956) modification of the technique given by Ball (1948).

Physical and chemical data. Monthly water samples were taken using an APHA sewage sampler. A Whitney electrical resistance thermometer was used to measure water temperature. The pH of the water was determined during a part of the study by a laboratory, line-operated Beckman pH meter. A Taylor block comparator was used in the field for the pH determination during the remaining time. A six inch Secchi's disc was used to estimate light penetration. The turbidity of the water was assayed using a Bausch and Lomb Spectronic 20 colorimeter following the procedure outlined by the Hach Chemical Company, Ames, Iowa.

The Alsterberg modification of the Winkler Method of dissolved oxygen determination was used following the procedure outlined in the 10th edition of *Standard Methods for the Examination of Water, Sewage, and Industrial Wastes* (1955). Phenolphthalein and methyl alkalinities were determined following the procedure given by Welch (1948). Methyl organge alkalinity was obtained by using M-Alka Ver indicator supplied by the Hach Chemical Company, Ames, Iowa.

Physical Features

Bottom sediments. The 0-1.0 meter zone was characterized by sandy silt with much detritus. Plant fragments, especially bits of alligator weed and cutgrass, were concentrated in this zone. Near the end of December, 1957, and throughout much of January, 1958, leaves from sycamore, *Platanus occidentalis* L., located nearby became so abundant upon the bottom that the dredge frequently was prevented from closing properly and had to be reset.

A very distinct shell zone existed in the 1.1-2.0 meter zone. Sublette and Sublette (1958) and Moore (1950, 1952) did not find such a zone in other Louisiana impoundments. Less detritus was present in the second zone and a considerable amount of sand and sandy silt was evident.

The sediment of the 2.1-2.8 meters zone was a soft, brown, flocculent mud with some plant fragments.

Thermal characteristics. In general, the lake showed a strong tendency toward thermal stratification from April to September. However, due to the shallow nature of the lake, the exposure to wind, and the direction of the lake's main axis, thermally stratified waters with an epilimnion, thermocline, and hypolimnion which fit the criteria used by limnologists for other North American lakes were not observed.

On the occasions when a thermocline occurred (July 2, July 16, July 30, September 3, October 14, November 2, December 4, December 16, and April 7) it was present from the surface to a point near the middle or extended from the surface to the bottom (May 17). Isothermal water was frequently observed in January and February. Similar conditions were observed by Moore (1952) on Lake Chicot and Sublette and Sublette (1958) on Chaplain's Lake.

Although only incipient stratification was observed, oxygen depletion in bottom waters persisted throughout the summer months.

Transparency. The maximum Secchi's disc reading was 1.0 meter with a turbidity of 15 ppm, recorded on July 13, and the minimum of 0.3 meter with a turbidity of 58 ppm was obtained December 4. These findings agree well with the result obtained by Geagan and Allen (1961) on lower sections of the lake where a three year average gave 1.99 feet (0.66 meter).

The lake manifested a well-developed phytoplankton but allochthonous sediments were the apparent cause of the much reduced transparency.

Chemical Features

Dissolved oxygen. Although a complete oxygen depletion was recorded only on three occasions (July 13, August 17, and May 17), in direct accordance with the thermal gradients recorded on those dates, there was a general tendency for bottom waters to be depleted of oxygen during the warm seasons. The lowest concentration of oxygen at the surface was 6.2 ppm on August 17, and the highest value of 16.0 ppm was observed on February 22. Geagan and Allen (1961) did not find values as low at the transects where they sampled in the lower (southern) part of the lake.

That a thorough mixing of the water occurred in January is reflected by the homogeneity of water temperatures from surface to bottom and by only a slight difference in surface and bottom oxygen values for the month.

Alkalinity. Normal carbonate was lacking in both surface and bottom waters the entire year. Bicarbonates were the sole source of alkalinity. During most of the study only slight variations were observed between amounts recorded from surface and bottom waters. With two exceptions (September 30, January 4) larger amounts were recorded from bottom water. The highest value obtained from the surface was 172.0 ppm (August 17) with a low of 20.0 ppm (May 17). On May 17, when Cane River Lake showed strong thermal gradients, a value of 234.0 ppm was recorded for bottom water. This is in agreement with Moore's (1950) observations on Lake Providence that higher alkalinity occurred in the lower stratum during periods of thermal stratification.

Hydrogen ion concentration. Surface hydrogen ion concentration varied from pH 6.7 to 8.5 and that of the bottom from pH 6.7 to 7.7. The bottom pH dropped slightly during May, June, July and August which seemed to be in accordance with other changes that occurred.

Results and Discussion

Composition and seasonal changes in the bottom fauna. Conventionally, three major life-zones on the floor of thermally stratified lakes have been recognized: the littoral, sublittoral, and profundal. As these terms have been employed, the littoral extends from the water's edge to the lakeward limits of rooted aquatic vegetation; the profundal occupies all of the lake floor bounded by the hypolimnion; and the sublittoral lies in an intermediate position between the two and represents a zone of transition.

While these have proved useful in previous studies, they do not adequately present the limits of the life-zones found in Cane River Lake. Instead, zonation of the lake floor which approximated meter contours proved more useful and accurate. The littoral zone as evidenced by bottom sediments and associated animal assemblages, encompassed the area between the shoreline and the 1.0 meter contour, although the rooted aquatic plants extended only to about 0.5 meter depth. The 1.1-2.0 meters zone included the sublittoral (=ecotone, cf. Sublette, 1957) or zone of transition from coarse littoral to finer profundal sediments. The profundal zone, with its finely divided, somewhat flocculent yellowish-brown sediments, was located beyond the 2.0 meters contour and made up most of the lake floor.

Table 1.
Mean annual standing crop of bottom fauna, Cane River Lake, Louisiana.

ORGANISMS	0-1.0 M		1.1-2.0 M		2.1-3.0 M	
	No./M²	Vol./M²	No./M²	Vol./M²	No./M²	Vol./M²
Oligochaeta	3295	3.9	3922	6.7	754	3.4
Chironomidae	2201	1.9	841	1.95	184	2.8
Chaoborus	–	–	25	0.09	945	1.75
Ceratopogonidae	6	0.01	8	0.01	4	0.01
Ephemeroptera	5	0.04	3	0.34	–	–
Zygoptera	29	0.45	–	–	–	–
Anisoptera	–	–	10	0.33	–	–
Corixidae	14	0.01	–	–	–	–
Gastropoda	538	–	705	–	22	–
Pelecypoda	54	–	–	–	–	–
Hirudinea	26	0.17	–	–	–	–
Turbellaria	14	0.01	–	–	–	–
Mean Total Organisms	6192	6.49	5514	9.42	1909	7.96

Qualitatively and quantitatively, a diversified fauna composed principally of oligochaetes, fewer chironomids, and still smaller numbers of snails and small clams existed in the 0-1.0 meter zone (Table 1). A graphic representation of the total organisms (exclusive of Mollusca) for each zone is presented in Figure 1.

The fauna of the 2.1-3.0 meters zone was made up of relatively large numbers of *Chaoborus* (Culicidae: Diptera), restricted almost entirely to this zone, and oligochaetes, with a very small number of chironomids. A few gastropods occasionally were taken there. These two zones lost their distinctiveness in the transition area and merged together. Oligochaetes, chironomids, and gastropods, in that order, were the major components.

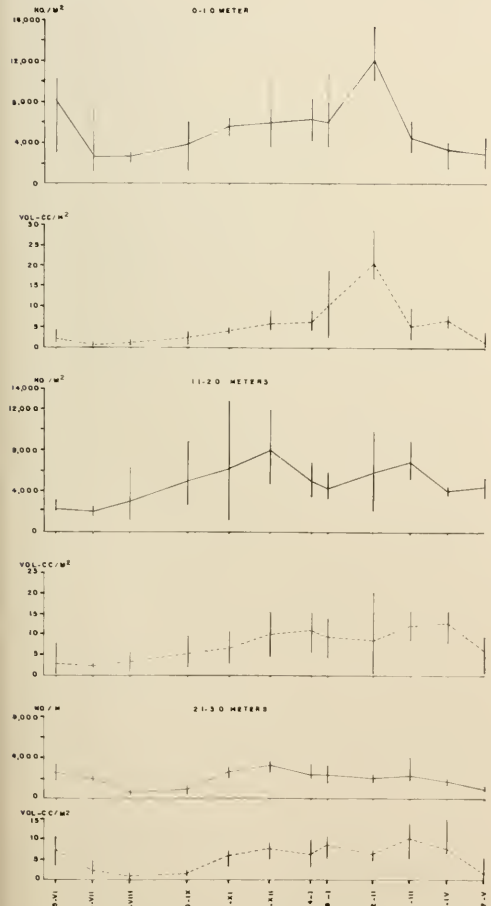

Figure 1. Seasonal abundance of all organisms averaged together. (mean number, solid line; mean volume, dashed line).

The relationship between numbers and volumes of the aquatic earthworms is shown in Table 1. An inverse relationship between numbers and volumes of chironomids was observed in the littoral and profundal zones with the largest number but smallest volume recorded in the 0-1.0 meter zone and the smallest number and largest volume in the 2.1-3.0 meters zone.

The predaceous ceratapogonids were distributed almost uniformly. Immature forms

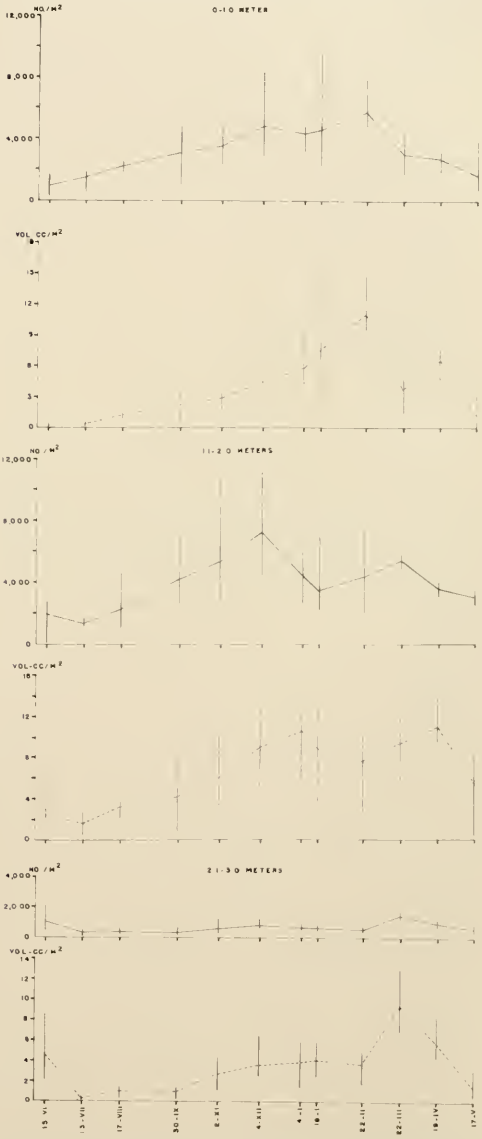

Figure 2. Seasonal occurrence of Oligochaeta (mean number, solid line; mean volume, dashed line).

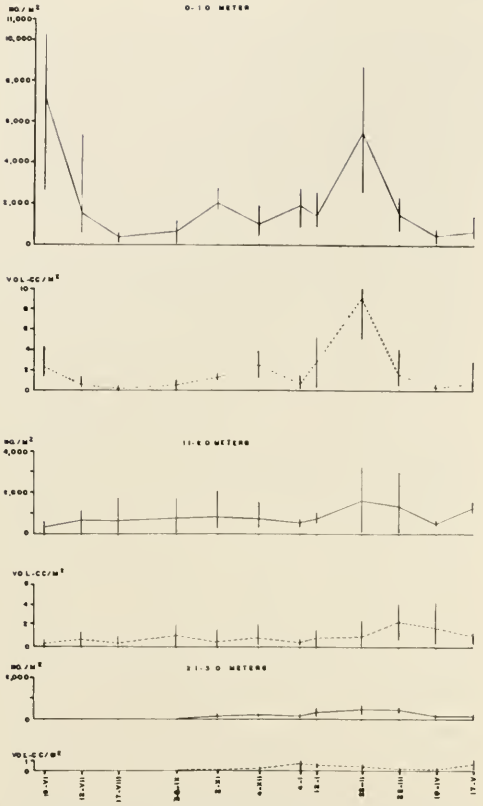

Figure 3. Seasonal abundance of larval Chironomidae, all species averaged together (mean number, solid line; mean volume, dashed line).

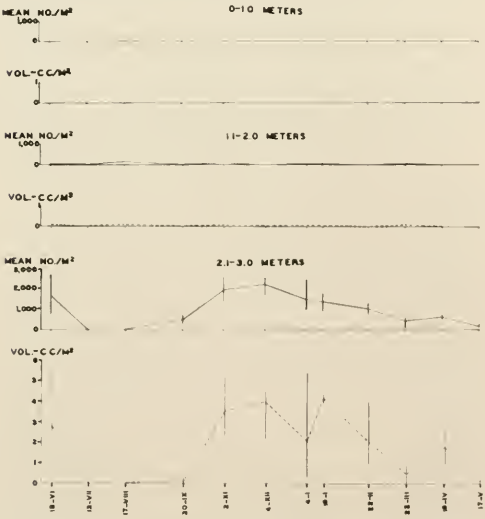

Figure 4. Depth distribution and seasonal abundance of *Chaoborus punctipennis* (Say), (mean number, solid line; mean volume, dashed line).

of the three gastropods, *Campeloma lewisi* (Walker), *Physa integra* (Haldeman), and *Helisoma trivolvis* (Say), were collected frequently in the deeper water as well as the shallow zone. The gastropods were identified by a comparison with specimens identified by Dr. R. Tucker Abbott, The Academy of Natural Sciences of Philadelphia.

Seasonal variations in the benthic assemblages are shown in Fig. 1. Figures 2, 3, and 4 show seasonal trends for each of the three major components: Oligochaeta, Chironomidae, and *Chaoborus*.

Population increases occurred in late winter and again in the spring. Frequently we observed that the volumes increased following a peak in the numbers. This was apparently due to the maturation of the organisms.

The distribution of larval Chironomidae (Fig. 3) during the cold and warm seasons reflected the physical and chemical conditions of the lake during those periods. The virtual absence of chironomids in the deep water during June, July, August, and September is a manifestation of the tendency toward thermal stratification of the lake and the associated poor supply of oxygen. At all other seasons the lack of prolonged thermal and accompanying chemical stratification allowed at least some species to distribute themselves within the profundal zone.

Chaoborus punctipennis (Say) was the most characteristic animal of the profundal bottom during the daylight hours. It was not collected from the 0-1.0 meter zone at any time during the study and was recorded from the 1.1-2.0 meters only on seven occasions (Fig. 4) with the largest number taken August 17, 1957. On that date none were collected from the deeper water. The increase in numbers within the transition zone, presumably resulting from an upward migration to avoid stagnation effects, did not account for all of the profundal zone inhabiting *Chaoborus* that previously occurred there. After the August decline the number gradually increased until a peak was reached about the first of December.

The Emergence of Chironomidae

Forty-six species of Chironomidae were collected during the study. These have been treated taxonomically in Part I of this series. Table 2, which is a checklist of the chironomids found in Cane River Lake, sum-

TABLE 2.
A checklist of the chironomids of Cane River Lake together with the depth distribution based on emergence of adults (x = presence)

Species	Vegetation	0-1.0 Meter	1.1-2.0 Meters	2.1-3.0 Meters
TANYPODINAE				
Tanypus stellatus Coquillett		x		x
Tanypus n. sp. 1		x		
Tanypus n. sp. 2		x	x	
Procladius n. sp. 1			x	
Procladius (Psilotanypus) bellus (Loew)		x	x	x
Pentaneura (Pentaneura) planensis Johannsen	x			
Pentaneura (Pentaneura) pilosella (Loew)	x	x		
Ablabesmyia peleensis (Walley)	x			
Ablabesmyia rhamphe Sublette	x	x		
ORTHOCLADIINAE				
Cricotopus bicinctus (Meigen)	x	x		
Cricotopus remus Sublette	x	x		
Nanocladius alternantherae Dendy and Sublette	x	x	x	
CHIRONOMINAE				
CHIRONOMINI				
Pseudochironomus aix Townes	x	x		
Chironomus (Chironomus) natchitocheae Sublette		x	x	
Chironomus (Chironomus) attenuatus Walker	x	x	x	
Chironomus (Chironomus) fulvipilus Rempel	x			
Chironomus (Dicrotendipes) modestus Say		x		
Chironomus (Dicrotendipes) nervosus Staeger	x	x	x	
Chironomus (Xenochironomus) xenolabis Kieffer	x			
Chironomus (Endochironomus) nigricans Johannsen	x	x		
Chironomus (Cryptochironomus) monochromus v.d. Wulp	x	x		
Chironomus (Cryptochironomus) nigrovittatus Malloch		x	x	
Chironomus (Cryptochironomus) carinatus (Townes)	x	x		
Chironomus (Cryptochironomus) directus (Dendy and Sublette)	x	x		
Chironomus (Cryptochironomus) emorsus (Townes)	x	x	x	
Chironomus (Cryptochironomus) galeator (Townes)		x	x	x
Chironomus (Cryptochironomus) edwardsi (Kruseman)	x	x	x	
Chironomus (Cryptochironomus) ponderosus Sublette		x	x	
Chironomus (Cryptochironomus) fulvus Johannsen	x	x	x	
Glyptotendipes (Phytotendipes) lobiferus (Say)	x	x	x	
Glyptotendipes (Phytotendipes) meridionalis Dendy and Sublette	x	x		
Paralauterborniella elachista (Townes)	x			
Lauterborniella varipennis (Coquillett)	x	x		

TABLE 2. (Continued)
A checklist of the chironomids of Cane River Lake together with the depth distribution based on emergence of adults (x = presence)

Species	Vegetation	0-1.0 Meter	1.1-2.0 Meters	2.1-3.0 Meters
Stenochironomus macateei (Malloch)	x			
Pedionomus beckae Sublette	x	x		
Polypedilum (Polypedilum) trigonum Townes	x			
Polypedilum (Polypedilum) illinoense (Malloch)	x	x		
Polypedilum (Polypedilum) digitifer Townes	x	x	x	x
TANYTARSINI				
Tanytarsus (Cladotanytarsus) viridiventris Malloch		x		
Tanytarsus (Tanytarsus) confusus Malloch		x		
Tanytarsus (Tanytarsus) xanthus Sublette	x	x		
Tanytarsus (Tanytarsus) neoflavellus Malloch	x	x	x	
Tanytarsus (Tanytarsus) dendyi Sublette	x	x	x	
Tanytarsus (Tanytarsus) buckleyi Sublette	x			
Tanytarsus (Tanytarsus) quadratus Sublette	x	x	x	
Tanytarsus (Tanytarsus) recens Sublette	x			

marizes depth distribution, while phenology by months is presented in Table 3. Emergence of adult chironomids in relationship to water temperature is given in Table 4.

Seasonal variation. The very mild winters of this latitude were reflected in the reproductive behavior of the Chironomidae, with some adults emerging, and presumably mating, in every month of the year. However, the emergence from the lake did not occur uniformly. Two distinct periods were discernible in the total emergence for the year. One was from early April to late November (Fig. 5), coinciding with a marked rise in water temperature which occurred beginning about the first of March. The rate of emergence gradually increased throughout the early spring and summer, becoming highest in late September and early October. As water temperatures declined during the fall there was a parallel drop in numbers of midges emerging. The second period of emergence, or rather the lack of it, was from December to April during which time the low water temperatures were associated with a sparse emergence that was irregular in distribution. The two periods were particularly noticeable for those midges trapped over beds of aquatic vegetation (alligator weed).

Adults taken in tent traps over beds of mat vegetation perhaps represent two larval populations; namely, those from the underlying littoral floor and from the vegetation itself. These may be distinguished in the following manner: larvae inhabiting the vegetation beds would be represented by adults in tent traps above the vegetation beds only, whereas adults transforming from larvae on the littoral bottom would be taken not only in traps set over bare bottoms but also by traps set above vegetation.

However, the funnel traps over bare bottoms would take a preponderance of adults of the littoral bottom-inhabiting larvae, since those living on the bottom under the vegetation would tend to migrate laterally (as pupae) to avoid the dark, shadow-producing mass of vegetation above (Scott and Opdyke, 1941). If adults of a species occur in approximately equal numbers in traps from both the littoral floor and from vegetation, the species is assumed to have no substratum preference.

The emergence of chironomids from the

TABLE 3.
Phenology of emergence of adult chironomids by months

Species	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
TANYPODINAE												
Tanypus stellatus Coquillett								x	x	x		
Tanypus n. sp. 1										x		
Tanypus n. sp. 2								x		x		
Procladius (Procladius) n. sp. 1				x								
Procladius (Psilotanypus) bellus (Loew)			x	x	x	x	x	x	x	x	x	
Pentaneura (Pentaneura) planensis Johannsen						x		x				
Pentaneura (Pentaneura) pilosella (Loew)					x	x	x	x	x	x		
Alabesmyia peleensis (Walley)				x	x				x	x	x	
Ablabesmyia rhamphe Sublette					x	x	x	x	x	x		
ORTHOCLADIINAE												
Cricotopus bicinctus (Meigen)				x	x							
Cricotopus remus Sublette				x	x	x						
Nanocladius alternantherae Dendy and Sublette	x		x	x	x	x	x	x	x	x	x	x
CHIRONOMINAE												
CHIRONOMINI												
Pseudochironomus aix Townes				x	x	x	x	x	x	x		
Chironomus (Chironomus) natchitocheae Sublette									x	x		
Chironomus (Chironomus) attenuatus Walker			x	x	x	x	x		x	x	x	
Chironomus (Chironomus) fulvipilus Rempel											x	
Chironomus (Dicrotendipes) modestus Say							x					
Chironomus (Dicrotendipes) nervosus Staeger			x	x	x	x	x	x	x	x		
Chironomus (Xenochironomus) xenolabis Kieffer									x			
Chironomus (Endochironomus) nigricans Johannsen		x		x	x	x	x	x	x	x	x	x
Chironomus (Cryptochironomus) monochromus v.d. Wulp			x	x	x	x	x					
Chironomus (Cryptochironomus) nigrovittatus Malloch						x	x	x	x			
Chironomus (Cryptochironomus) carinatus (Townes)							x	x	x	x		
Chironomus (Cryptochironomus) directus (Dendy and Sublette)				x	x	x	x	x	x	x		
Chironomus (Cryptochironomus) emorsus (Townes)					x	x	x	x	x	x		
Chironomus (Cryptochironomus) galeator (Townes)						x		x	x	x	x	
Chironomus (Cryptochironomus) edwardsi (Kruseman)				x	x	x	x	x	x	x	x	x
Chironomus (Cryptochironomus) ponderosus Sublette					x			x		x		
Chironomus (Cryptochironomus) fulvus Johannsen			x	x	x	x	x	x	x	x		
Glyptotendipes (Phytotendipes) lobiferus (Say)			x	x	x	x	x		x	x		
Glyptotendipes (Phytotendipes) meridionalis Dendy and Sublette			x	x	x	x	x	x	x	x	x	
Paralauterborniella clachista (Townes)							x	x				
Lauterborniella varipennis (Coquillett)							x	x				
Stenochironomus macateei (Malloch)							x					

TABLE 3. (Continued)
Phenology of emergence of adult chironomids by months

Species	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Pediomomus beckae Sublette				x			x	x	x	x		
Polypedilum (Polypedilum) trigonum Townes				x					x			
Polypedilum (Polypedilum) illinoense (Malloch)				x	x			x		x	x	
Polypedilum (Polypedilum) digitifer Townes				x	x	x	x	x	x	x	x	
TANYTARSINI												
Tanytarsus (Cladotanytarsus) viridiventris Malloch						x	x				x	
Tanytarsus (Tanytarsus) confusus Malloch								x	x	x		
Tanytarsus (Tanytarsus) xanthus Sublette	x				x	x		x	x	x	x	x
Tanytarsus (Tanytarsus) neoflavellus Malloch	x		x	x	x	x	x		x	x	x	
Tanytarsus (Tanytarsus) dendyi Sublette		x	x		x							
Tanytarsus (Tanytarsus) buckleyi Sublette							x	x	x	x	x	x
Tanytarsus (Tanytarsus) quadratus Sublette		x	x		x			x				
Tanytarsus (Tanytarsus) recens Sublette					x							

littoral benthos (0-1.0 meter) occurred through the warmer months of the year with only slight peaks of abundance observed (Fig. 5). The mean annual emergence of adults per square meter from that area was about half the mean number which emerged per square meter from the vegetation (Table 1 and Fig. 5).

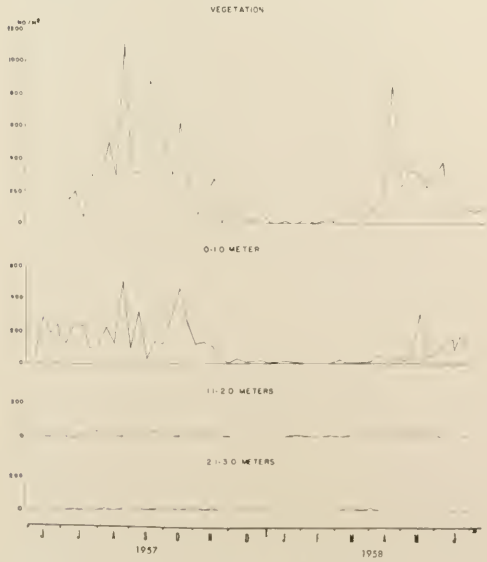

Figure 5. Emergence of adult Chironomidae, all species averaged together.

The number of adults emerging from the littoral zone was much greater than from the profundal (2.1-3.0 meters) and transition zones (1.1-2.0 meters) combined. The emergence of profundal chironomids occurred from July through November, 1957, and in March and April of 1958. The number of individuals arising from that area was small in comparison to the total emergence. In general, emergence decreased with an increase in depth.

Table 5 shows the mean annual emergence per square meter for all insects taken in traps. The caddisflies and mayflies were recorded primarily from the vegetation in April and May, 1958. A few emerged during late August and September, 1957. *Chaoborus* and ceratopogonids made up a very small part of the total organisms trapped during the year.

Species emerging from aquatic vegetation. Thirty-four species of Chironomidae were collected from tent traps set over vegetation. While most of these were also recorded in funnel traps set in shallow water, certain species showed a preference for vegetation habitats. Five species constituted about two-thirds of the total individuals from that location. In order of their abundance they were: *Chironomus (Cryptochironomus) directus* Dendy and Sublette, *Nanocladius*

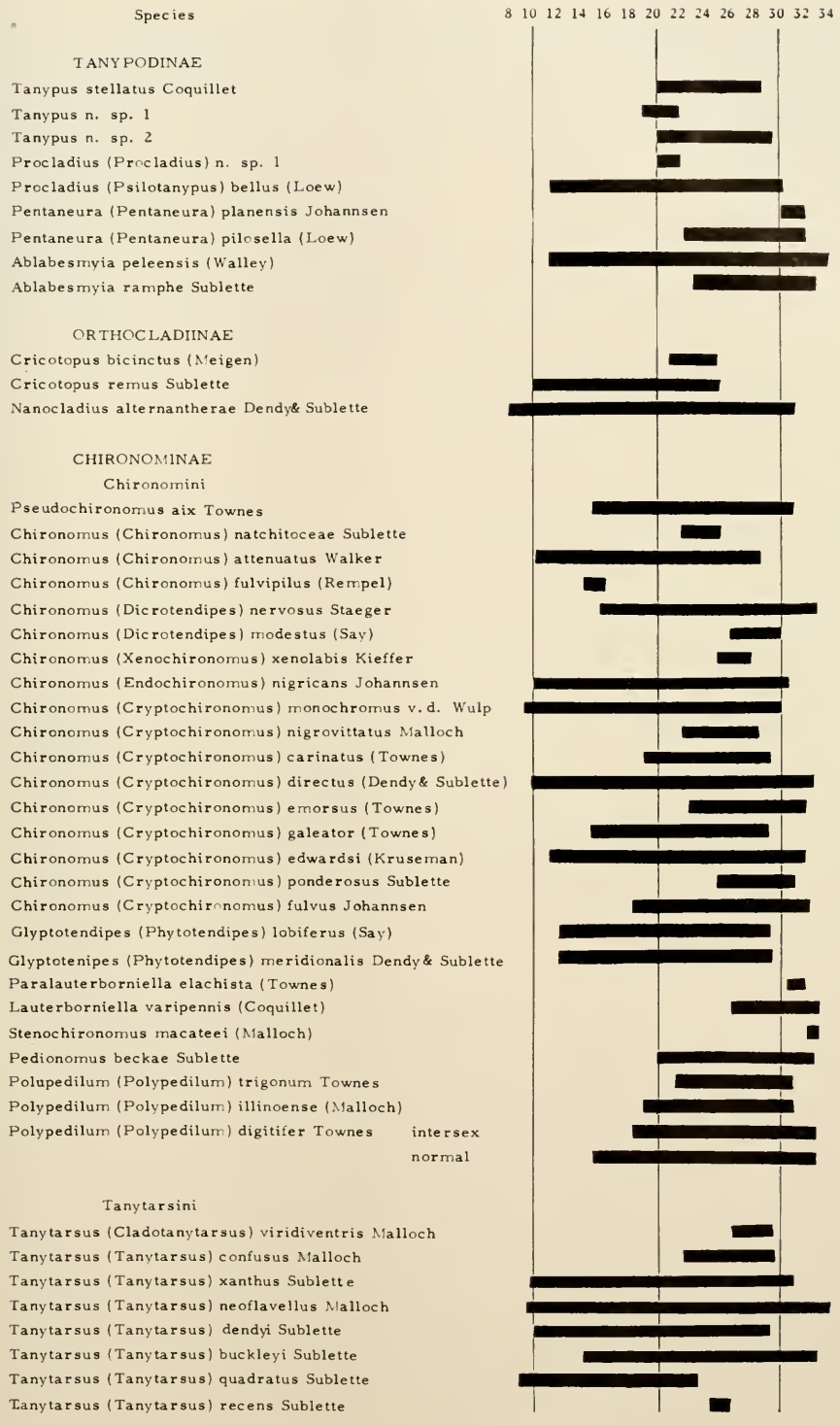

TABLE 4. EMERGENCE OF ADULT CHIRONOMIDS IN RELATIONSHIP TO WATER TEMPERATURE (DEGREES CENTIGRADE)

TABLE 5.
Mean annual emergence of aquatic insects, No./M²

Organism	Vegetation	0-1.0 M	1.1-2.0 M	2.1-3.0 M	Mean Total
Chironomidae	217.9	107.2	21.5	9.6	486.1
Trichoptera	19.4	3.0	0.56	–	22.96
Ephemeroptera	11.0	2.2	0.2	–	13.84
Chaoborus	0.66	0.2	0.19	1.9	2.96
Ceratopogonidae	0.64	0.59	–	–	1.23

alternantherae Dendy and Sublette, *Pseudochironomus aix* Townes, *Chironomus (Dicrotendipes) nervosus* (Staeger) and *Cricotopus remus* Sublette. With one exception, *Chironomus (Cryptochironomus) directus* was taken entirely from the aquatic vegetation (Fig. 6) and comprised one-third

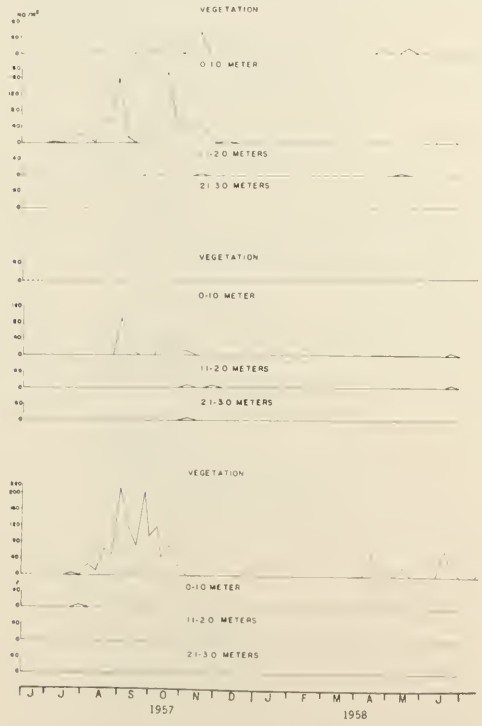

Figure 6. Emergence of adult males of *Chironomus (Cryptochironomus) edwardsi* (above); *Chironomus (Cryptochironomus) galeator* (middle); and *Chironomus (Cryptochironomus) directus* (below).

of the total number of chironomids emerging from vegetation. *Nanocladius alternantherae* and *Pseudochironomus aix* were important littoral forms which occurred primarily in the tent traps, but were occasionally collected in the funnel traps set on the bottom in the shallow water (Figs. 7 and 8). The occurrence of large number of *Pseudochironomus aix* in the spring suggests that the species has one generation each year.

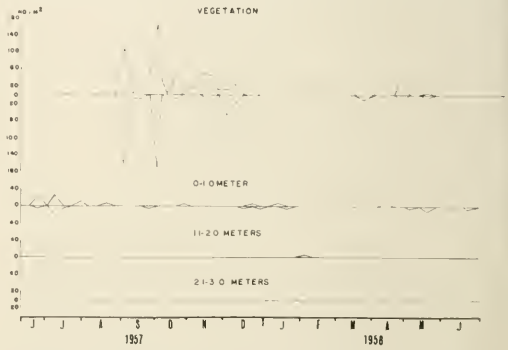

Figure 7. Emergence of adults of *Nanocladius alternantherae* (males, above abscissa; females, below).

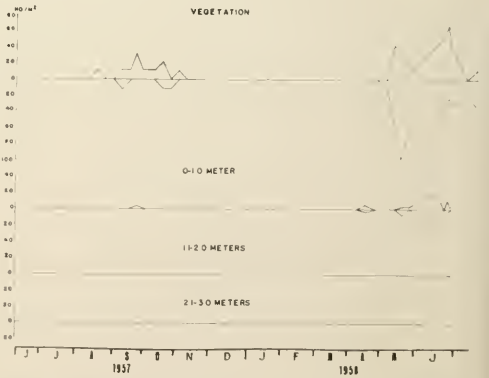

Figure 8. Emergence of adults of *Pseudochironomus aix* (males, above abscissa; females, below).

Cricotopus remus, like *Chironomus (Cryptochironomus) directus*, was limited to the vegetation but was taken in a funnel trap on one occasion. *Chironomus (Dircrotendipes) nervosus* was collected in about equal numbers from the tent and funnel traps.

Of the remaining twenty-nine species, only one or two specimens of *Chirono-*

mus (Xenochironomus) xenolabis (Kieffer), *Stenochironomus macateei* (Malloch) and *Chironomus (Chironomus) fulvipilus* (Rempel) were collected during the study. The other species occurred more frequently but were not numerous (Tables 2, 3, and 4).

Species emerging from the littoral benthos. The predominant species taken by the shallow water funnel traps was *Chironomus (Cryptochironomus) edwardsi* (Kruseman) (Fig. 6) followed closely by *Polypedilum (Tripodura) digitifer* Townes (Fig. 9). The

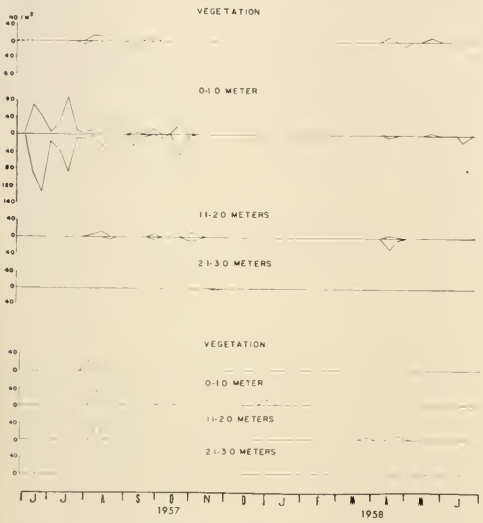

Figure 9. Emergence of adults of *Polypedilum (Polypedilum) digitifer*. Top figure, males (above abscissa) and females (below); bottom figure, intersexes produced by mermethid nematode infections.

relatively small number of *Chironomus edwardsi* taken from vegetation, when compared to the large number which emerged from the littoral bottom, suggests that the species is restricted to the bottom and that the individuals which were taken in the tent traps emerged from the bottom and passed up through the vegetation.

Other species which were frequently trapped were *Glyptotendipes (Phytotendipes) meridionalis* Dendy and Sublette, *Chironomus (Cryptochironomus) galeator* (Townes), *Nanocladius alternantherae* Dendy and Sublette, and *Tanytarsus neoflavellus* Malloch.

Thirty-six species were collected as they emerged from the littoral zone. Other than the species mentioned above, most occurred in small numbers (Tables 2, 3 and 4).

Species emerging from the sublittoral and profundal. The predominant species trapped was *Procladius bellus* (Loew) (Fig. 10) and, in keeping with its predaceous feeding habits, it was found widely distributed. Dur-

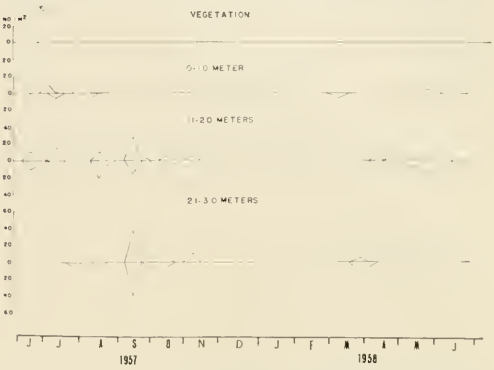

Figure 10. Emergence of adults of *Procladius bellus* (males above abscissa; females, below).

ing the year most of the individuals were taken in water 1 to 2 meters in depth. A few were trapped in the littoral zone during June and July, 1957, and in the spring of 1958.

Only one other species, *Tanypus stellatus* Coquillett, occurred more than once in the profundal zone and it emerged in small numbers. *Chironomus (Cryptochironomus) galeator* (Townes) occurred once in a funnel trap set in the profundal zone (Fig. 6). In general, emergence from depths greater than 1.0 meter was small and sporadic and represented the lower fringes of typical littoral inhabiting populations. A total of nineteen species was taken in small numbers below 1.0 meter depth (Table 2).

Miller (1941) reported *Cricotopus bicinctus* (Meigen) as a typical species found living below the thermocline in Costello Lake, Ontario. Only five individuals were trapped from Cane River Lake and those were taken from the littoral.

Sexual differences. Miller (1941) observed slight differences in the time of emergence and distribution of the sexes. Males showed a tendency to reach their peak of emergence a short time before females, and females were found to be more abundant in deeper water. These differences, he postulated, were in some way correlated with temperature.

Only slight sexual differences were noted

for three of the more common species found in Cane River Lake, *Nanocladius alternantherae* Dendy and Sublette, *Polypedilum digitifer* Townes, and *Procladius bellus* (Loew) (Figs. 7, 9, and 10). The ratio of total males to females of *Pseudochironomus aix* Townes for the year was about 1:1 (Fig. 8). However, a difference in the ratio of approximately 3:1 was recorded during the fall and a 1:3 ratio occurred in the spring. *Glyptotendipes meridionalis* Dendy and Sublette also showed an unusual ratio of males to females (Fig. 11). A ratio of three males to one female occurred throughout the year.

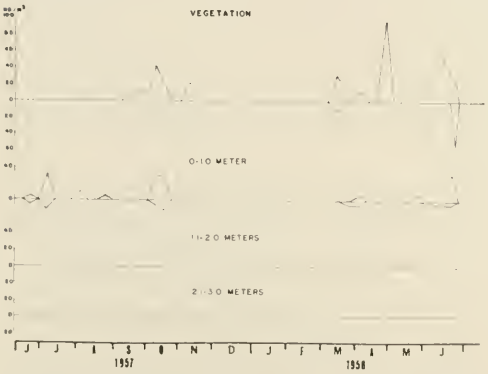

Figure 11. Emergence of adults of *Glyptotendipes (Phytotendipes) meridionalis* (males, above abscissa; females, below).

Intersexuality in a species of Chironomidae. Intersexes of *Polypedilum digitifer* Townes were trapped on several occasions, as has been reported for other chironomids (Wülker, 1961, gives a review of mermithid parasitism in the Chironomidae). The individuals collected showed various degrees of intersexuality and typically bore the characteristic female antennae, and a short, thickened abdomen with much reduced male genitalia. Occasionally, a specimen was taken with an antenna approaching the typical plumose condition of the male.

Diel periodicity. The results of the three attempts to determine daily rhythms of emergence are presented in Figure 12. The greatest emergence of Chironomidae, July 9, 1957, and June 10, 1958, took place between 5 and 9 P.M. A decline in emergence occurred during the next four hours. On June 19, 1958, the traps were lifted at two-hour

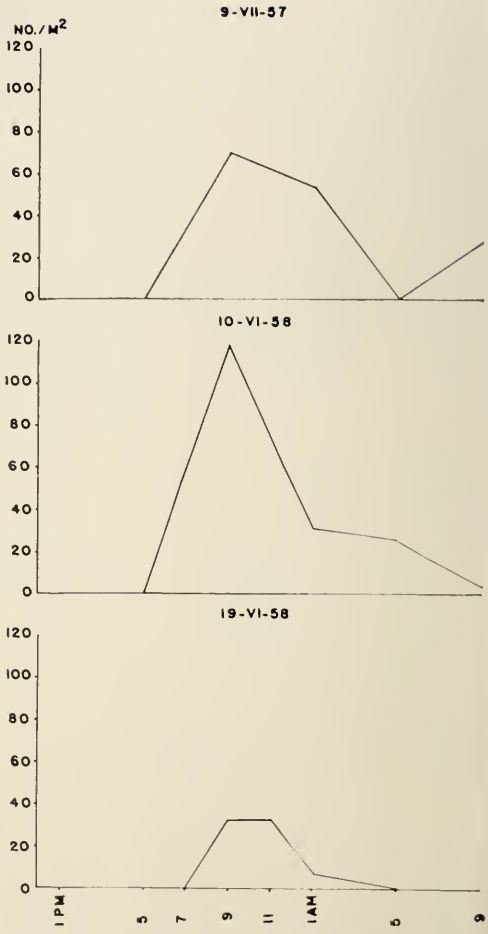

Figure 12. Diel cycle of emergence, all species together, at three selected dates.

intervals from 5 to 1 A.M. in order that more precise periods of emergence might be determined. No adults emerged between 5 and 7 P.M. and equal numbers emerged between 7 and 9 P.M. and 9 and 11 P.M. Emergences declined between 11 P.M. and 1 A.M. No emerging adults were trapped during hours of high light intensity.

Summary

1. This study of the benthic faunal assemblages and the emergence of Chironomidae from Cane River Lake was made from June, 1957, to July, 1958. It is the fourth bottom faunal study which has been made on lakes in Louisiana and the first study in Southern United States in which the emergence of Chironomidae was investigated.

2. The purpose of the study was to secure quantitative and qualitative data on the benthic organisms, particularly the Chironomidae, through collections made from larval populations and from adults taken by tent and funnel trappings. Collections were made using such devices to facilitate positive identifications.

3. Cane River Lake is an impoundment of what was once a channel of Red River. The lake has a length of 34.5 miles, a mean width of 250 feet and an area of 1,044 acres. Run-off is the principal supply of water.

4. The lake has a well developed zone of emergent vegetation. It exhibited a strong tendency toward thermal stratification from April to September but did not stratify stably. Complete oxygen depletion in bottom water occurred on several occasions in accordance with the strong thermal gradients and partial stratification. Bicarbonates were the sole source of alkalinity.

5. Qualitatively and quantitatively, a diversified fauna occurred in the littoral zone. Fewer groups occurred in the profundal. The principal components of the benthos were Oligochaeta, Chironomidae, and *Chaoborus* in that order.

6. The distribution of Chironomidae during the cold and warm seasons reflected the physical and chemical conditions of the lake during those periods. Some chironomids were found distributed in the profundal zone during the cold season but were virtually absent during the warm season.

7. Forty-six species of Chironomidae were collected during the study, including nine Tanypodinae, three Orthocladiinae, twenty-six Chironomini, and eight Tanytarsini.

8. Some adults emerged during every month of the year but two distinct peaks of emergence occurred. One peak was observed during the spring and early summer and the other in the fall.

9. Emergence from the littoral zone was much greater than emergence from the sublittoral and profundal zones combined. A greater number of adults emerged from the aquatic vegetation than from the littoral benthos. Emergence from the littoral bottom occurred from May to November with only slight peaks of numbers observed.

10. In general, the period of greatest emergence of chironomids coincided with a low population of larvae. With an increase in depth the number of larvae recorded and the number of adults emerging decreased.

11. Of the thirty-four species of chironomids taken from the vegetation, five species, *Chironomus (Cryptochironomus) directus, Nanocladius alternantherae, Pseudochironomus aix, Chironomus (Dicrotendipes) nervosus,* and *Cricotopus remus* constituted about two-thirds of the total number of individuals.

12. Thirty-six species of chironomids were trapped from the littoral benthos. The predominant species encountered were *Chironomus (Cryptochironomus) edwardsi* and *Polypedilum digitifer.*

13. Three species were trapped from the profundal with *Procladius bellus* the predominant species.

14. Only slight differences in the emergence of males and females were observed for the three most common species, *Nanocladius alternantherae, Polypedilum digitifer,* and *Procladius bellus.* Differences in the ratio of males to females of *Pseudochironomus aix* and *Glyptotentdipes meridionalis* were recorded.

15. Intersexes of *Polypedilum digitifer* showing various degrees of intersexuality were trapped on several occasions.

16. Limited diel sampling showed that the greatest emergence of chironomids occurred between 5 and 11 P.M.

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Abstract

Buckley, Burton R. (Northwestern State College, Natchitoches, Louisiana) and James E. Sublette (Eastern New Mexico U., Portales). II. The limnology of the upper part of Cane River Lake, Natchitoches Parish, Louisiana, with particular reference to the emergence of Chironomidae.

Cane River Lake is a shallow impoundment of what was once a channel of Red River. It has a well developed zone of emergent vegetation. While it does not develop stable thermal stratification, it does show occasional oxygen depletion from bottom water during summer months. The principal components of the benthos are Oligochaeta, Chironomidae, and *Chaoborus*, in that order. Forty-six species of chironomids were collected with emergence of some species occurring during every month of the year. Greatest emergence periods coincided with lowest larval population levels. Number of species by site of emergence was thirty-four from vegetation, thirty-six from littoral benthos, and three from the profundal benthos. Intersexuality of *Polypedilum digitifer* Townes is reported. Greatest period of diel emergence was between five and eleven P.M.

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DIGENETIC AND ASPIDOGASTRID TREMATODES FROM MARINE FISHES OF CURAÇAO AND JAMAICA†

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II. Introduction and Historical Review

This paper concerns adult digenetic trematodes parasitizing marine fishes of Curaçao and Jamaica and is a continuation of a study begun by one of us (R.M.C.) in Puerto Rico in 1951 and reported in a series of publications (Cable, 1954a, 1954b, 1956a, 1956b; LeZotte Jr., 1954; Siddiqi and Cable, 1960). Results of that investigation indicated need for further study of larval and adult trematodes of shallow waters adjacent to Carribbean islands separated by deep water which could serve to isolate certain populations of intermediate and definitive host species.

During 1961 the authors spent 7 months in the Caribbean region, 3 in Curaçao and 4 in Jamaica. The purpose of the trip was twofold: (1) the examination of as many shallow-water fishes as possible with emphasis on duplicate or congeneric species from the two localities, and (2) the study of cercariae and as many of their life histories as time and facilities permitted. Four papers reporting life cycles and larval trematodes have appeared (Cable, 1962; Cable and Nahhas, 1962, 1963; Cable, 1963).

The work on digenetic trematodes in the Western Atlantic-Gulf-Caribbean region was pioneered by Linton who reported about 75 species from Woods Hole, Mass. (1898, 1900, 1901, 1940) and several additional ones from Beaufort, North Carolina (1905), Bermuda (1907) and Tortugas, Florida (1910). Those areas were restudied by a number of investigators and especially by Manter, whose papers appearing from 1925 to 1949 have made the region one of the better known so far as its trematode fauna is concerned. Other contributions have been made by Hanson (1950) who studied Barker's collection from Bermuda, and by Sparks (1957, 1958, 1960) who investigated the trematode fauna of the Bahama Islands and Grand Isle, Louisiana. Sogandares-Bernal (1959) compared the faunas of Bimini and the Panama Pacific and, in a series of papers in collaboration with others (Sogandares-Bernal and Hutton, 1959a, 1959b, 1959c; and Sogandares-Bernal and Sogandares, 1961), studied the helminth parasites from Tampa and Boca Ciega Bays, Florida, and the Atlantic Coast of Panama. In Cuba, Pérez Vigueras (1940a, 1940b, 1955a, 1955b, 1955c, 1956, 1958) reported a number of trematodes from several vertebrates including marine fishes. Major studies on larval forms have been made by Cable (1956b) who reported 51 marine cercariae from Puerto Rico, and by Holliman (1961) who described 28 species from the Apalachee Bay area of Florida. Less comprehensive studies will be cited in the discussion of species.

During this study, we examined 1527

† Based on a thesis of the first author, submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, Purdue University, August, 1963.

fishes representing 185 species. Of these, 698 individuals belonging to 124 species were collected in Curaçao, and 829 representing 127 species in Jamaica. Common to both localities were 68 species, of which 5 harbored no endoparasitic trematodes. The same was true of 34 species in Curaçao and 21 in Jamaica. Usually, but not always, species negative for parasites were represented by individuals that were immature or few in number.

Fishes from both localities yielded a total of 178 species of mature aspidogastrid and digenetic trematodes. Of these, 100 were found in Curaçao and 140 in Jamaica, with 62 common to both localities. Included were 40 new species, of which 20 occurred in Curaçao and 25 in Jamaica, with 5 common to both. One of the 5 was reported in connection with its life history (Cable and Nahhas, 1962); this paper includes descriptions of the remaining 39 new species in presenting and discussing data concerning the trematode fauna of Caribbean fishes. The system of La Rue (1957) is used for higher taxa, with a major revision concerning the position of the acanthocolpids in his system.

III. Methods

Fishes were obtained from several sources including traps, nets, spear-fishing, use of rotenone, and commercial fishermen. Whenever possible, fish were kept alive in tanks and killed shortly before examination; others were examined as soon as possible, usually within two hours of death. When time permitted, the trematodes were studied alive, particularly to determine the extent of the bladder and other aspects of the excretory system. After removal from the host, they were washed in 0.7% saline and fixed with corrosive sublimate-acetic acid solution under light coverglass pressure. The worms were transferred to a dish, left in fixative for up to several hours, depending on the size of the worms, washed in several changes of water, dehydrated to 70%, left in 70% iodine-alcohol overnight to remove excess mercury, and stored in small vials of 80% alcohol. Most of the specimens were stained with Semichon's carmine, cleared in methyl salicylate and mounted in damar.

Most of the figures and their scales were drawn by microprojection but a few were free-hand. Differences in depth of focus may result in some dimensions not corresponding with text figures: the measurements given in text are exact. Measurements are in millimeters except where indicated as being in microns. Sucker ratios were calculated from the average of the length plus the width, and are expressed with the oral sucker taken as 1.

Type specimens of all new species and representatives of a few previously described ones are deposited in the Helminthological Collection of the United States National Museum. One asterisk indicates a new host record; two a new synonymy. The letters C and J indicate localities, Curaçao and Jamaica, respectively.

IV. Description and Discussion of Species

FAMILY ASPIDOGASTRIDAE Poche, 1925

Cotylogaster basiri Siddiqi & Cable, 1960
Host: **Calamus bajanado* (J).
Site: intestine.

Lobatostoma ringens (Linton, 1905) Eckmann, 1932

Synonyms: Aspidogaster ringens Linton, 1905; *Cotylogaster chaetodipteri* MacCallum, 1921.
Host: **Micropogon furnieri* (J).
Site: intestine.

The above species, like the freshwater aspidogastrids, probably are primarily parasites of mollusks but are able to survive and even flourish in the intestine of vertebrates that feed on those hosts. Quantities of mollusk shells were found in the digestive tract of all of the fishes that harbored aspidogastrids.

Superorder *Anepitheliocystidia* La Rue, 1957
Order *Strigeatoidea* La Rue, 1926
Suborder *Brachylaimata* La Rue, 1957
Superfamily *Bucephaloidea* La Rue, 1926

FAMILY BUCEPHALIDAE Poche, 1907

Bucephalus varicus Manter, 1940

Hosts: Caranx bartholomaei (J); *C. crysos* (C); *C. hippos* (C, J); *C. latus* (C, J); *C. ruber* (C, J); **Chloroscombrus chrysurus* (J); **Seriola dumerili* (J).
Site: ceca and intestine.

A great deal of variation was observed in the specimens from the several hosts and from individuals of the same host species. These variations may be explained by the condition of the worms at the time of fixation, their age, and possibly development in different host species.

Bucephalus scorpaenae Manter, 1940
Host: Scorpaena plumieri (C, J).
Site: ceca and intestine.

The Curaçao material is in almost complete agreement with Manter's description. The specimens from Jamaica have a somewhat longer cirrus sac which sometimes extends to the anterior margin of the anterior testis.

The next species is figured and described but not named because only a single specimen was found and it does not show such diagnostic features as the shape of the tentacles and extent of the excretory vesicle.

Bucephalus sp.
Figure 1

Host: Centropomus undecimalis (J).
Site: ceca.
Deposited specimen: U.S.N.M. 60248.

Description: Body elongate, tapering posteriorly, truncate anteriorly, 1.03 long, 0.20 wide at level of ovary. Entrie cuticle spinose. Rhynchus sucker-like, 0.173 long, 0.20 wide, its tentacles retracted, probably 7 in number. Pharynx about equatorial in position, 0.053 long, 0.060 wide; esophagus not evident; cecum subtriangular. Gonads in posterior half of body. Testes tandem, contiguous, to right of mid-line, 0.090-0.117 long, 0.083 wide; cirrus sac 0.347 long, 0.058 wide, containing ovoid seminal vesicle and long pars prostatica surrounded by prostate cells. Genital atrium wide, spherical. Vitellaria 12-14 follicles on each side, anterior to pharynx. Ovary 0.060 long, 0.100 wide, anterior to testes, at about level of seminal vesicle; uterine seminal receptacle present; uterus extending anterior to vitellaria, containing few normal eggs, 15-17 by 10-12 μ. Excretory vesicle tubular, anterior extent not determined.

The next species, although previously reported, is redescribed for reasons given below.

Alcicornis carangis MacCallum, 1917
Figure 2

Host: Caranx ruber (C).
Site: intestine.
Deposited specimen: U.S.N.M. 60249.

Description based on 3 specimens. Body elongate, 1.58-2.1 long, 0.30-0.40 wide. Entire cuticle spinose. Rhynchus wedge-shaped, 0.566-0.633 long, 0.167-0.200 in greatest width; tentacles 7, varying in shape and length with degree of extension, 0.180-0.267 long exclusive of filament, 0.030-0.045 wide at base; each with 2 lateral prongs and terminal filament, proximal prong more than twice as long as distal one; filament may be lost. Pharynx, seen in only one specimen, at level of anterior testis, 0.060 in diameter; esophagus not evident; cecum mostly anterior to anterior testis. Testes tandem, contiguous, to right of midline, level variable, 0.120-0.186 in diameter; cirrus sac 0.567-0.580 long, 0.100-0.133 wide, on left side of body, containing ovoid seminal vesicle, long pars prostatica and prostate cells. Ovary entire, anterior to testes, 0.133-0.146 long, 0.080-0.100 wide; uterus voluminous, extending from rhynchus to posterior end of body, sometimes overlapping posterior end of rhynchus. Genital atrium wide; genital pore at a distance from posterior end of body. Vitellaria in 2 lateral groups of 12-17 follicles each, mostly in anterior half of body. Eggs 18-22 by 13-15 μ. Excretory vesicle not seen; excretory pore terminal.

This species was known only from its incorrect description by MacCallum (1917) until it was found again by Pérez Vigueras (1955a). Our specimens agree with his redescription and show tentacles which have 2 lateral prongs. MacCallum described the tentacles as being "branched like the antlers of a deer" and his figure shows a single prong on each tentacle. In our specimens, the number of prongs visible depends on the degree to which the tentacle is extended. Thus in the same individual, one tentacle may show both prongs and another only the distal one.

Siddiqi and Cable (1960) reported *A. carangis* from *Caranx ruber* in Puerto Rico. Comparing their specimens with ours indicates that their material represents a new species of *Alcicornis,* for which the name *A. siddiqii* is proposed. The following description was included by Siddiqi and Cable in

their original manuscript from which redescriptions of known species were deleted before publication.

Alcicornis **siddiqii** n.sp.
Figure 3

Synonym: ***Alcicornis carangis* of Siddiqi & Cable, 1960, nec MacCallum, 1917.

Host: Caranx ruber (Puerto Rico).

Site: stomach.

Holotype: U.S.N.M. 39302 (deposited by Siddiqi & Cable).

"Description based on 10 specimens: Body 0.884-1.293 long, 0.165-0.198 wide; cylindrical posteriorly, tapering anteriorly. Cuticle spinose. Rhynchus wedge-shaped, 0.118-0.147 by 0.067-0.099 exclusive of tentacles of which there are 7, each with 2 processes; cilium absent. Pharynx spherical. 0.039-0.045 in diameter, somewhat posterior to midlevel and submedian; intestinal sac median, small, equatorial. Testes 2, entire, 0.082-0.097 by 0.075-0.090, tandem, contiguous, submedian to right, overlapped by pharynx and cirrus sac. Cirrus sac within posterior half of body, contaning sac-like seminal vesicle, long pars prostatica and prostate cells; genital pore ventral, a short distance from posterior end of body. Ovary entire, 0.070-0.096 by 0.066-0.075, submedian, anterior to testes and intestine; seminal receptacle absent. Vitellaria scanty, in 2 short lateral bands of small follicles immediately anterior to ovarian level. Uterus voluminous, confined to posterior 2/3 of body, extending slightly anterior to vitellaria. Eggs numerous, 0.024-0.026 by 0.012-0.014. Excretory vesicle tubular, extending to level of vitellaria; excretory pore terminal, without evident sphincter."

Of the 4 species of *Alcicornis* that have been previously recognized, *A. siddiqii* differs from *A. carangis* in size of rhynchus, in the anterior extent of the uterus and evidently by lacking tentacular filaments; from *A. baylisi* Nagaty, 1937, in having a smaller *rhyncus,* shorter excretory vesicle and more anterior vitellaria; from *A. longicornutus* Manter, 1954, in having relatively much shorter tentacles with 2 prongs each; and from *A. cirrudiscoides* Velasquez, 1959, in having much smaller eggs.

Dollfustrema macracanthum Hanson, 1950

Hosts: Gymnothorax moringa (C); **G. vicinus* (C).

Site: intestine.

Deposited specimen: U.S.N.M. 60250.

This species was described by Hanson as having one testis. Her material included 80 specimens but her description is based on "eleven larger specimens, and particularly the holotype." A reexamination of the type specimen reveals to us what looks like the faint outline of an anterior testis located at about the same level as the one seen distinctly in our material.

Dollfustrema muraenae Sogandares-Bernal, 1959

Hosts: **Gymnothorax funebris* (J); **G. moringa* (C, J).

Site: intestine.

Deposited specimen: U.S.N.M. 60251.

The most distinctive features of this species are the position of the vitellaria and the 3 rows of slender spines on the rhynchus. In our 37 specimens, topography of the gonads varies. The testes are usually symmetrical but may be diagonal, often with the right testis anteriormost. The ovary is usually nearer the left testis and either anterior to it or between the testes. The uterus occupies all available space between the rhynchus and the posterior end of the body. In contracted specimens, the rhynchus is drawn into the expanded anterior end of the body so that the vitellaria form a semicircle just posterior to the rhynchus and the cecum is drawn closer to that organ. Eggs in the Curaçao specimens measure 24-26 by 15-18 μ, and in the Jamaican material 24-28 by 16-21; Sogandares-Bernal (1959) gave a range of 24-33 by 19-27.

Dollfustrema **gymnothoracis** n.sp.
Figure 4

Host: Gymnothorax vicinus (C).

Site: upper intestine.

Holotype: U.S.N.M. 60252.

Description based on 18 specimens. Body elongated oval, more pointed posteriorly, 1.03-1.66 long, 0.400-0.714 wide. Entire cuticle spinose. Rhynchus 0.098-0.120 long, 0.120-0.165 wide, sucker-like when inverted; with 5 or 6 rows of spines, 5 μ long, which, except for being closer together than those on adjacent cuticle, are not noticeably differ-

ent from spines elsewhere. Pharynx at level of gonads, 0.060-0.075 in diameter; esophagus about same length as pharynx, cecum directed anteriorly. Testes symmetrical in younger specimens, diagonal in larger ones, 0.135-0.200 long, 0.075-0.113 wide; cirrus sac 0.293-0.333 long, 0.093-0.146 wide, containing elongated seminal vesicle, long pars prostatica and prostate cells. Ovary intertesticular, close to right testis, 0.100-0.113 long, 0.068-0.105 wide; uterus extending anteriorly in front of vitellaria, but never reaching rhynchus, and posteriorly almost to end of cirrus sac. Genital atrium spacious; genital pore ventral, well removed from posterior end of body. Vitelline follicles form an inverted U extending anteriorly from midlevel of testes in immature specimens, distinctly anterior to testes in older ones, but never intruding into anterior fifth of body length. Eggs thick-shelled, 33-42 by 22-27 μ. Excretory vesicle tubular extending to about anterior end of cirrus sac.

The arcuate arrangement of the vitelline follicles and the more posterior testes distinguish this species from all others in the genus except *D. echinatum* (Komiya and Tajimi, 1941). That species, known only from the metacercaria, differs from *D. gymnothoracis* in having a conical rather than cup-shaped rhynchus. In other respects, *D. gymnothoracis* is similar to *D. muranae* and *D. bipapillosum* Manter and Pritchard, 1961. In those species, however, the vitellaria and uterus extend to the rhynchus which is larger than in *D. gymnothoracis,* and has rows of long spines well differentiated from the adjacent body spines.

Nearly all of our specimens of *D. gymnothoracis* were massively infected with coccus-like granules.

Rhipidocotyle baculum (Linton, 1905) Eckmann, 1932

Synonyms: Gasterostomum baculum Linton, 1905; *Gasterostomum* sp. Linton, 1901; *Nannoenterum baculum* (Linton, 1905).

Host: **Scomberomorus cavalla* (C).

Site: intestine and ceca.

Our material is referred to *Rhipidocotyle baculum* as described by Linton (1901, 1905); his later paper (1940) evidently includes more than one species as *Nannoenterum baculum. Rhipidocotyle baculum* is very similar to *R. adbaculum* Manter, 1940, which Manter (1940c) distinguished on the basis of "size and shape of the cephalic disc which in *R. adbaculum* is larger and has a dorsal point. The body is larger and more elongate." In body shape, our material is more like *R. baculum.* The shape of the cephalic disc is variable but in no case was a dorsal point evident nor did the cephalic disc extend laterally beyond the edges of the body. In some specimens, the uterus extends to the anterior level of the vitellaria.

Siddiqi and Cable (1960) reported *Prosorhynchus stunkardi* from *Scomberomorus* sp. A reexamination of paratypes indicates that *P. stunkardi* is a synonym of either *R. baculum* or *R. adbaculum.* Because the specimens were dead when removed from the host, the body and cephalic disc are not normal in shape.

Bucephaloides longoviferus (Manter, 1940) Hopkins, 1954

Synonyms: ***Bucephalopsis longoviferus* Manter, 1940; *Gasterostomum* sp. Linton, 1910 in part.

Host: Sphyraena barracuda (C, J).

Site: ceca and intestine.

Bucephaloides longicirrus (Nagaty, 1937) Hopkins, 1954

Synonyms: Bucephalopsis arcuatus of Manter, 1940, nec Linton, 1900; *B. arcuatus* of Siddiqi & Cable, 1960, nec Linton, 1900.

Host: Sphyraena barracuda (C, J).

Site: ceca and intestine.

Discussion: Manter 1963b draws attention to the fact that in the specimens from *Sphyraena barracuda* referred by him (1940c) and by Siddiqi and Cable (1960) to *Bucephaloides arcuatus,* the excretory vesicle does not extend beyond the pharynx whereas it terminates well anterior to that structure in the species as originally described by Linton (1900). We have confirmed that difference between *B. longicirrus* and *B. arcuatus* in both the Puerto Rican specimens and the present ones.

Bucephaloides arcuatus (Linton, 1900) Hopkins, 1954

Synonyms: Gasterostomum arcuatum Linton, 1900; *Gasterostomum* sp. Linton, 1900; *Bucephalopsis arcuatus* (Linton, 1900) Eckman, 1932.

Host: **Scomberomorus cavalla* (C, J).

Site: intestine and ceca.

Prosorhynchus atlanticum Manter, 1940

Synonyms: Gasterostomum sp. Linton, 1910 from *M. bonaci; Gasterostomum* sp. Linton, 1910 from *M. venonosa.*

Hosts: Mycteroperca bonaci (C, J); **M. falcata* (C); *M. venonosa* (C).

Site: ceca and intestine.

Manter (1940c) distinguished this species from *P. pacificum* by the larger eggs with thicker and darker shells. Hanson (1950) was of the opinion that the 2 overlapped in that respect and synonymized them. *P. pacificum* has eggs 24-27 by 12-17 whereas they measure 29-36 by 18-24 in our specimens and 31-36 by 21-24 in those of Siddiqi and Cable (unpublished data). We regard that difference as being of specific magnitude.

Prosorhynchus aguayoi Pérez Vigueras, 1955

Host: Rypticus saponaceus (C, J).

Site: intestine.

Deposited specimen: U.S.N.M. 60253.

Eggs from the Curaçao material tend to be shorter and wider (38-43 by 24-27 μ) than those from Jamaica (40-46 by 21-26) but their measurements overlap. Pérez Vigueras gave an average egg size of 40 by 26.

Prosorhynchus promicropsi Manter, 1940

Host: Promicrops itaiara (J).

Site: intestine.

Prosorhynchus ozakii Manter, 1934

*Host: *Mycteroperca bonaci* (C).

Site: intestine.

Superfamily *Fellodistomatoidea* La Rue, 1957

FAMILY FELLODISTOMATIDAE Nicoll, 1913

Antorchis urna (Linton, 1910) Linton, 1911

Synonym: Mesorchis urna Linton, 1910.

Hosts: Pomacanthus arcuatus (C, J); *P. paru* (C, J).

Site: ceca and intestine.

Antorchis holacanthi Siddiqi & Cable, 1960

Host: Holacanthus tricolor (J).

Site: ceca.

Mesolecitha linearis Linton, 1910

*Synonym: **Proctoeces neomagnorus* Siddiqi & Cable, 1960.

Host: Acanthurus coeruleus (J).

Site: intestine.

Reexamination of the type of *Proctoeces neomagnorus* revealed the presence of cirrus spines which in combination with a spherical rather than tubular seminal vesicle distinguish the genus *Mesolecitha* from *Proctoeces. P. neomagnorus* thus agrees with *Mesolecitha linearis* as does our single specimen and is reduced to synonymy with that species.

Proctoeces maculatus (Looss, 1901) Odhner, 1911

Synonyms: Distomum subtenue Linton, 1907; *Proctoeces subtenuis* (Linton) Hanson, 1950; *Proctoeces erythraeus* Odhner, 1911.

*Host: *Lactophrys tricornis* (J).

Site: intestine.

Heretofore, this trematode has been reported from species of *Calamus.* Our single specimen from a trunkfish may represent an accidental infection.

Proctoeces lintoni Siddiqi & Cable, 1960

*Hosts: *Calamus arctifrons* (J); **C. bajanado* (J).

Site: intestine.

Tergestia acuta Manter, 1947

Hosts: Caranx bartholomaei (J); **C. crysos* (J).

Site: intestine.

Tergestia laticollis (Rud., 1819) Stossich, 1899

Synonyms: Distoma laticolle Rudolphi, 1819; *Pharyngora polonii* Molin of Olsson, 1869.

*Host: *Clepticus parrae* (C, J).

Site: intestine.

Tergestia pectinata (Linton, 1905) Manter, 1940

Synonyms: Distomum pectinatum Linton, 1905; *Theledra pectinata* (Linton, 1905) Linton, 1910.

*Hosts: *Caranx bartholomaei* (J); **C. hippos* (J); *C. latus* (C, J); **Oligoplitis saurus* (J); **Opisthonema oglinum* (J); *Selar crumenophthalmus* (J).

The next species closely resembles the genus *Tergestia* except that the oral sucker does not have lobes and the cervical region lacks the lateral folds characteristic of that

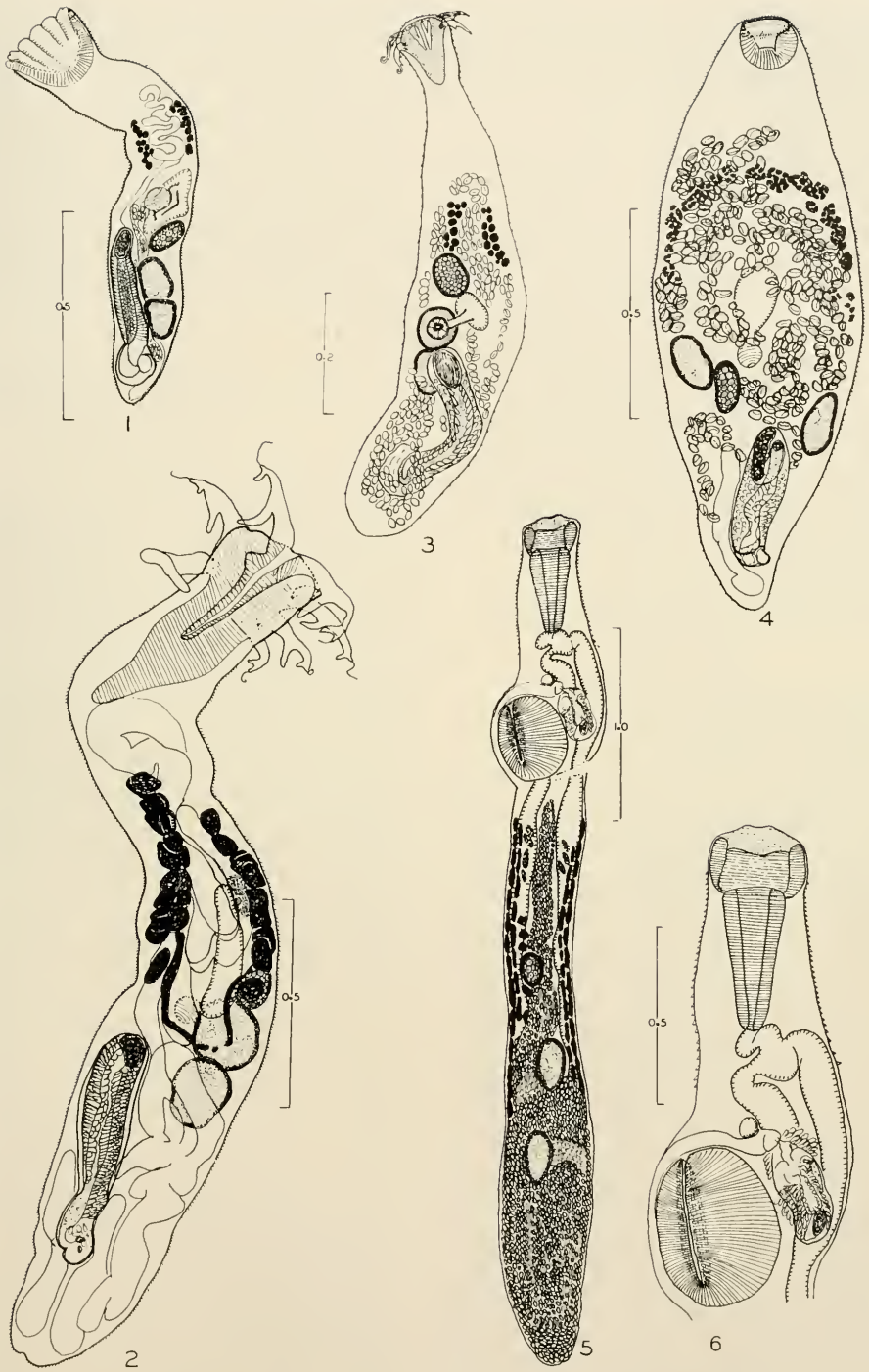


Figure 1. *Bucephalus* sp., dorsal view. **Figure 2.** *Alcicornis carangis,* dorsal view. **Figure 3.** *Alcicornis siddiqii,* holotype, ventral view (from Siddiqi and Cable, 1960). **Figure 4.** *Dollfustrema gymnothoracis,* holotype, ventral view. **Figure 5.** *Gymnotergestia chaetodipteri,* holotype, ventral view. **Figure 6.** Same, forebody enlarged.

genus. To receive the species, a new genus is proposed and characterized as follows; the generic name refers to the absence of ornamentation of the forebody:

Gymnotergestia n.g.

Diagnosis: Fellodistomatidae. Distomes with elongated body; cuticle unarmed, annulated, especially in forebody. Oral sucker cup-shaped, without lobes. Prepharynx absent; pharynx elongated, conical; ceca long. Testes 2, diagonal or tandem; cirrus sac well-developed, at level of acetabulum; external seminal vesicle absent. Ovary pretesticular; true seminal receptacle absent; uterus voluminous, extending posterior to gonads; metraterm muscular. Vitelline follicles numerous, in lateral fields posterior to acetabulum. Genital pore median, anterior to acetabulum. Excretory vesicle Y-shaped. Parasites in intestine of marine fishes.

Type and only species:

Gymnotergestia chaetodipteri n.g., n.sp.

Figures 5 and 6

Host: Chaetodipterus faber (J).
Site: lower intestine.
Holotype: U.S.N.M. 60254.

Description based on 3 specimens. Body slender, 1.66-4.28 long, 0.380-0.567 wide at level of acetabulum. Cuticular rings of forebody giving lateral margins a serrated appearance. Oral sucker 0.140-0.187 long, 0.200-0.280 wide; ventral sucker 0.320-0.440 long, 0.247-0.340 wide, with longitudinal aperture; sucker ratio 1:1.67. Hindbody 2-3 times length of forebody. Pharynx 0.300-0.413 long, 0.123-0.173 in greatest width; esophagus short; ceca extending to posterior end of body. Testes 2, diagonal or tandem, 0.173-0.286 long, 0.140-0.173 wide, separated by uterine coils; posttesticular space one-half as long to equal length of forebody. Cirrus sac large, to left of ventral sucker, containing saccular seminal vesicle, large pars prostatica and long folded cirrus. Ovary entire, pretesticular, 0.126-0.186 long, 0.106-0.133 wide, separated from anterior testis by uterine coils. Uterine seminal receptacle present; uterus voluminous, occupying most of hindbody; metraterm half as long as cirrus sac, muscular. Genital atrium small; genital pore median, a short distance anterior to ventral sucker. Eggs thick-shelled, 30-36 by 20-25 μ. Vitelline follicles in lateral fields between acetabulum and posterior testis. Excretory vesicle bifurcating at ovarian level, its arms extending to sides of pharynx to receive main collecting tubules.

The larva of this species probably is similar to *Cercaria caribbea XL* which Cable (1956b) described from Puerto Rico. It has the elongated pharynx characteristic of *Gymnotergestia chaetodipteri* and lacks the oral lobes that are known to be developed in at least some cercariae of the genus *Tergestia.*

Infundibulostomum anisotremi n.sp.

Figure 7

Host: Anisotremus virginicus (J).
Site: intestine.
Holotype: U.S.N.M. 60255.

Description based on a single specimen. Body ovoid, more broadly rounded anteriorly than posteriorly, 0.767 long, 0.374 wide. Cuticle spinose, spines extending to posterior level of testis. Eye-spot pigment absent. Oral sucker 0.078 long, 0.083 wide; ventral sucker about equatorial, 0.063 long, 0.069 wide; sucker ratio 1:0.71. Prepharynx 0.013 long; pharynx 0.040 long, 0.033 wide; esophagus slightly shorter than pharynx; ceca short, extending to near posterior level of vitellaria. Testis somewhat irregular, submedian, 0.105 long, 0.159 wide; cirrus sac arcuate, to left of ventral sucker, containing large internal seminal vesicle and prostatic complex; external seminal vesicle immediately posterior to ventral sucker. Ovary entire, to left of midline, at level of testis, 0.111 by 0.075; seminal receptacle median to ovary; uterus filling posttesticular space, extending anteriorly to form convolutions on right side of body between testis and level of intestinal bifurcation, metraterm simple. Genital pore median, immediately anterior to acetabulum. Eggs numerous, 18-21 by 10-13 μ. Vitellaria in 2 lateral clusters of 6 or 7 follicles each, at level of acetabulum. Excretory vesicle not observed.

Infundibulostomum anisotremi, the second species in its genus, differs from *I. spinatum* Siddiqi & Cable, 1960, in the shape of the body, extent of spination, shape and size of the oral sucker, and the sucker ratio.

The systematic position of species assigned to the genus *Bacciger* is confused by the ab-

sence of a distinct cirrus in *B. harengulae* which led Yamaguti (1958) to assign that genus to the family Cryptogonimidae. He stated that a cirrus sac is absent because Stossich did not show that structure in *B. bacciger* even though both Nicoll (1914) and Palombi (1934) clearly described a cirrus sac in species in *Bacciger.* We have found a well-developed cirrus sac in a species from *Opisthonema oglinum* but it is absent in another from *Sardinella macrophthalmus.* Evidently the two cannot be assigned to the same genus and therefore we restrict to the genus *Bacciger* those species having a cirrus sac and erect a new genus as follows for those in which it is absent:

Pseudobacciger n.g.

Diagnosis: Fellodistomatidae. Body short; cuticle spinose; eye-spot pigment absent; distomate, ventral sucker in anterior half of body. Pharynx and esophagus present; ceca not extending to posterior end of body. Testes 2, symmetrical, postacetabular; cirrus sac absent. Ovary intertesticular; seminal receptacle present; uterus chiefly posttesticular. Vitellaria compact, lateral masses in acetabular region. Eggs small. Excretory vesicle V-shaped. Parasites in intestine and ceca of marine fishes. Type species: *Pseudobacciger harengulae* (Yamaguti, 1938) n.comb.; (Synonym: *Bacciger harengulae*). other species: *Pseudobacciger manteri* n.sp.

Pseudobacciger manteri n.g., n.sp.

Figure 8

Synonym: ***Bacciger harengulae* of Manter, 1947, nec Yamaguti, 1938.

Host: Sardinella macrophthalmus (J).

Site: ceca.

Holotype: U.S.N.M. 60256.

Description based on 20 specimens. Body oval to pyriform, 0.373-0.747 long, 0.266-0.420 wide. Entire cuticle spinose. Oral sucker terminal, 0.045-0.068 in diameter; ventral sucker preequatorial, 0.057-0.090 in diameter; sucker ratio 1:1-1.3. Prepharynx not evident; pharynx 0.033-0.045 in diameter; esophagus 1-2 times length of pharynx; ceca extending a short distance posterior to testes. Testes 2, equatorial to somewhat preequatorial, symmetrical, 0.060-0.090 long, 0.065-0.105 wide; cirrus sac absent; seminal vesicle indistinctly bipartite, extending slightly posterior to ventral sucker; pars prostatica indistinct. Ovary irregular to lobed, 0.060-0.090 in diameter, intertesticular, median, at about posterior level of testes; seminal receptacle small, overlapping ovary or not; uterus chiefly posttesticular; metraterm simple. Genital atrium small; genital pore median, near intestinal bifurcation. Vitelline follicles in 2 largely extracecal groups of 7-10 each at about level of ventral sucker. Eggs 21-24 by 15-20 μ. Excretory vesicle V-shaped, with arms passing ventral to ceca, to terminate at esophageal level; excretory pore terminal.

Manter (1947) reported this species as *Bacciger harengulae* Yamaguti, 1938, from 3 specimens of which one was partly crushed. He noted its resemblance to Yamaguti's material but indicated that it differed in having more rounded eggs and somewhat longer ceca; he was unable to see the excretory vesicle. Measurements given by Yamaguti overlap those of the present species which has consistently longer ceca and arms of the bladder extending farther anteriorly than in the Japanese species.

The next species is named with hesitation because it may be the one that Price (1934) described as *Steringotrema ovata* from a single specimen. Both occur in the same host species and agree in all respects except the topography of the gonads. Price's specimen was examined but it was faded and the gonads were so indistinct that their identity and arrangement could not be determined with certainty.

Bacciger **opisthonemae** n.sp.

Figure 9

Host: Opisthonema oglinum (J).

Site: ceca and intestine.

Holotype: U.S.N.M. 60257.

Description based on 6 specimens. Body oval to somewhat pyriform, 0.386-0.493 long, 0.240-0.300 wide. Entire cuticle with fine spines; eye-spot pigment absent. Suckers subequal, 0.042-0.067 in diameter, oral sucker slightly subterminal, ventral sucker about equatorial. Prepharynx not evident; pharynx 0.033-0.037 in diameter; esophagus very short; ceca extend to or slightly beyond midlevel of hindbody. Testes 0.040-0.060 in diameter, smooth or somewhat irregular, symmetrical to slightly diagonal, near posterior margin of ventral sucker; cirrus sac pyriform, 0.090-0.112 long by 0.051-0.060

wide, median, anterior to or slightly overlapping ventral sucker, containing saccate seminal vesicle, pars prostatica, conspicuous prostate cells and cirrus. Ovary 0.040-0.068 in diameter, median to submedian, intertesticular or slightly posterior to level of testes; uterus mostly postovarian; metraterm simple. Vitelline follicles in 2 groups of 5-8 each, mostly extra-cecal, near level of acetabulum. Genital pore median or slightly submedian, near posterior edge of pharynx. Excretory vesicle V- or Y-shaped with short stem, arms extending to pharyngeal level.

Removing from the genus *Bacciger* species lacking a cirrus sac leaves only *B. bacciger* (Rud., 1819) and *B. nicolli* Palombi, 1934. Both differ from the present species in having shorter ceca and more extensive vitellaria with follicles extending well into the forebody.

Suborder *Azygiata* La Rue, 1957
Superfamily *Azygioidea* Skrjabin & Guschanskaja, 1956
FAMILY BIVESICULIDAE Yamaguti, 1939

Bivesicula caribbensis Cable & Nahhas, 1962
Host: Myripristis jacobus (C, J).
Site: pyloric ceca.

Order *Echinostomida* La Rue, 1957
Suborder *Paramphistomata* Szidat, 1936
Superfamily *Paramphistomatoidea* Stiles & Goldberger, 1910
FAMILY PARAMPHISTOMATIDAE Fischoeder, 1901

The following species is identified as the one Pérez Vigueras (1940a) described as *Macrorchitrema havanensis.* In erecting the genus *Macrorchitrema,* he discussed various genera of amphistomes but did not mention *Cleptodiscus* with which *Macrorchitrema* is clearly synonymous. Our specimens and his were from the same host species and because his description is not complete or generally available, the species is redescribed as follows:

Cleptodiscus havanensis (Vigueras, 1940) n.comb.
Synonym: ***Macrorchitrema havanensis* Vigueras, 1940.
Host: Holacanthus tricolor (J).
Site: intestine.
Deposited specimen: U.S.N.M. 60258.

Description based on 3 specimens. Body broadly rounded posteriorly, tapering anteriorly, 4.57-5.79 long, 1.35-1.64 in maximum width. Cuticle thin, with a few minute spines near anterior end of body; eye-spot pigment present. Pharynx 0.233-0.266 long, 0.166-0.200 wide, with 2 retrodorsal diverticula. Ventral sucker at posterior end of body, 1.20-1.35 long, 0.965-1.06 wide, with longitudinal aperture. Esophagus 0.868-1.013 long, 0.040-0.060 in maximum width at muscular bulb near intestinal bifurcation, surrounded by gland cells along entire length; ceca not extending posterior to ovary. Testes 2, irregular to lobed, 0.466-0.714 long, 0.366-0.667 wide, diagonal, close together or separated by coils of uterus; anterior testis and cirrus sac near intestinal bifurcation; cirrus sac pyriform to spherical, 0.185-0.225 long, 0.135-0.180 wide, containing sinuous internal seminal vesicle, pars prostatica, prostate cells, and relatively short cirrus; sac followed by very long, convoluted seminal vesicle. Ovary smooth, 0.220-0.266 in diameter, near anterior edge of acetabulum, to right or left (in one specimen) of midline; seminal receptacle not evident; Mehlis' gland posterior to ovary; uterus mostly dorsal, between acetabulum and anterior testis. Genital pore midventral, at or slightly anterior to intestinal bifurcation. Eggs thick-shelled, more pointed at one end, 60-86 by 40-51 μ. Vitelline follicles in lateral fields, extending from anterior edge of acetabulum to about midlevel of anterior testis. Excretory system not observed. Lymphatic channels two, extracecal, extending from near posterior end of body to sides of oral sucker.

This species is distinguished from *C. reticulatus* Linton, 1910, by the much larger ventral sucker, its longitudinal aperture and the more anterior position of the testes and vitellaria. Hanson (1955) described a bipartite cirrus sac in *C. bulbosus,* a species which is more like *C. reticulatus* than the present one. In our specimens, the external seminal vesicle may be compactly coiled or not and, because of the adjacent membranes of the lymph channels and parenchymal vesicles, appears to be embedded in a relatively much denser tissue that could be mistaken for the posterior division of a bipartite cirrus sac.

Superfamily *Notocotyloidea* La Rue, 1957

FAMILY PRONOCEPHALIDAE Looss, 1902

Glyphicephalus candidulus (Linton, 1910) Siddiqi and Cable, 1960

Synonyms: Himasomum candidulum Linton, 1910; *Barisomum candidulum* (Linton) Price, 1931; *Pleurogonius candidulus* (Linton) Manter, 1947.

Hosts: Angelichthys ciliaris (J); *Pomacanthus arcuatus* (J).

Site: intestine.

Suborder *Echinostomata* Szidat, 1939

Superfamily *Haploporoidea* Mehra, 1961

Mehra (1961) proposed the superfamily Haploporoidea to include the Haploporidae, Waretrematidae, Haplosplanchnidae and Megaperidae. Although the first 2 families are questionably distinct, Cable (1962) gave evidence that they are closely related to the Haplosplanchnidae. As to the Megaperidae, its placement with those families in a common superfamily is less certain because the development of the excretory system was not observed when Cable (1954b) reported the only cercaria known to be a megaperid larva. Thus it is not certain that the primary excretory pores are in the tail and that the bladder lacks an epithelium as would be expected if the megaperids were closely related to the other families that Mehra has placed in the Haploporoidea. Although Manter erected the family Megaperidae, he later (1963a) reduced it to the rank of a subfamily in the Lepocreadiidae; Cable (1954b) had previously suggested a close affinity with that family. However, it seems likely that further studies may support Mehra and for that reason, his view is tentatively accepted here by including the Megaperidae in the Haploporoidea. At this point it may be noted that the genera *Enenterum, Cadenatella,* and *Jeancadenatia* which generally are placed in the Lepocreadiidae, have many features in common with those of families included in the Haploporoidea and ultimately may be transferred to that superfamily. In the absence of life history studies, however, those genera are tentatively retained in the Lepocreadiidae.

FAMILY HAPLOPORIDAE Nicoll, 1914

Hapladena varia Linton, 1910

Hosts: Acanthurus hepatus (C, J); *A. coeruleus* (J).

Site: intestine.

The specimens from Curaçao were mostly immature but a few were sufficiently developed to make identification possible. Cable (1962) described the first haploporid cercaria and suggested on morphological and ecological evidence that it may be the cercaria of *H. varia.*

Hapladena ovalis (Linton, 1910) Manter, 1947

Synonym: Deradena ovalis Linton, 1910.

*Hosts: *Sparisoma brachiale* (J); *S. flavescens* (J); **Pseudoscarus guacamaia* (J).

Site: intestine.

Allomegasolena spinosa Siddiqi & Cable, 1960

Hosts: Chaetodipterus faber (J); **Lutianus apodus* (J).

Site: ceca.

Five specimens agree with the description given by Siddiqi and Cable except that sucker ratio may reach 1:1.68 and the eggs attain a length of 75 μ.

Megasolena archosargi Sogandares-Bernal & Hutton, 1959

*Host: *Archosargus unimaculatus* (J).

Site: intestine.

Eight specimens from 5 fish are in agreement with the description given by Sogandares-Bernal and Hutton (1959a) except in the size of the eggs which in our material measure 60-75 by 39-47 μ as compared with 73.5-88.2 by 42-48.3.

FAMILY HAPLOSPLANCHNIDAE Roche, 1925

Haplosplanchnus **mugilis** n.sp.

Figure 10

Host: Mugil curema (C).

Site: intestine.

Holotype: U.S.N.M. 60259.

Description based on 13 specimens. Body elongated, tapering posteriorly, 0.780-1.15 long, 0.220-0.467 wide. Cuticle aspinose; eye-spot pigment present. Oral sucker 0.075-0.120 long, 0.083-0.135 wide; ventral sucker 0.138-0.180 long, 0.096-0.168 wide, on a short peduncle; sucker ratio 1:1.27-1.55. Prepharynx short; pharynx 0.037-0.063 in diameter; esophagus as long as pharynx; cecum extending to about anterior level of ovary. Testis entire, 0.150-0.165 long, 0.083-0.120 wide, about midway between acetabu-

lum and posterior end of body; seminal vesicle tubular, sometimes reaching level of ovary; pars prostatica large, spherical to ovoid; prostate glands diffuse, inconspicuous; ejaculatory duct short. Ovary entire, anterior to testis, 0.090-0.120 long, 0.053-0.105 wide; seminal receptacle dorsal, near ovary; uterus extending posterior to testis. Genital pore midway between pharynx and acetabulum. Eggs 48-63 by 30-36 μ, containing oculate miracidia. Vitellaria of 10-12 inconspicuous follicles scattered between posterior edge of seminal vesicle and anterior third of testis. Excretory bladder not observed; its pore terminal.

This is the first species of *Haplosplanchnus* to be reported from the Gulf-Caribbean region. Of the 3 previously described species, *H. mugilis* is most like *H. pachysomus* (Eysenhardt, 1829), but differs in having a shorter seminal vesicle, shorter peduncle of the acetabulum, a spherical or ovoid pars prostatica and the uterus extending posterior to the testis. It differs from *H. caudatus* (Srivastava, 1939) in the same respects and also in body shape. In *H. purii* Srivastava, 1939, the testis is in the extreme posterior end of the body, the cecum and seminal vesicle are long, the vitellaria are compact, and the pars prostatica tubular.

Schikhobalotrema acutum (Linton, 1910) Skrjabin & Guschanskaja, 1955

Synonyms: Deradena acuta Linton, 1910; *Haplosplanchnus acutus* (Linton) Manter, 1937.

Hosts: **Strongylura ardeola* (C); *S. raphidoma* (J); *S. timucu* (C).

Site: intestine.

Schikhobalotrema adacutum (Manter, 1937) Skrjabin & Guschanskaja, 1955

Synonym: Haplosplanchnus adacutus Manter, 1937.

Hosts: Abudefduf saxatilis (J); **Halichoeres pictus* (J); **Hemiramphus brasiliensis* (C, J); **Hepsetia stipes* (J).

Site: intestine.

Schikhobalotrema obtusum (Linton, 1910) Skrjabin & Guschanskaja, 1955

Synonyms: Deradena obtusa Linton, 1910; *Haplosplanchnus obtusus* (Linton) Manter, 1937.

Host: Acanthurus hepatus (C).

Site: intestine.

Schikhobalotrema adbrachyurum Siddiqi & Cable, 1960

Hosts: **Sparisoma flavescens* (C); **S. viride* (C); **Pseudoscarus guacamaia* (C, J); **P. plumbaeus* (J).

Site: intestine.

Schikhobalotrema pomacentri (Manter, 1937) Skrajabin & Guschanskaja, 1955

Synonym: Haplosplanchnus pomacentri Manter, 1937.

Hosts: **Pomacentrus analis* (C); **P. fuscus* (C, J); **P. leucosticus* (C); **Microspathodon chrysurus* (C, J).

Site: intestine.

Schikhobalotrema sparisomae (Manter, 1937) Skrjabin & Guschanskaja, 1955

Synonym: Haplosplanchnus sparisomae Manter, 1937.

Hosts: **Pseudoscarus guacamaia* (C, J); **Scarus croicensis* (C); **Scarus* sp. (J); **Sparisoma abildgaardi* (C, J); **S. brachiale* (J); **S. flavescens* (J); **S. radians* (J).

Site: intestine.

Schikhobalotrema **bivesiculum** n.sp.

Figure 11

Host: Abudefduf saxatilis (J).

Site: intestine.

Holotype: U.S.N.M. 60260.

Description based on 6 specimens. Body elongated, more tapered posteriorly than anteriorly, 0.965-1.40 long, 0.347-0.467 wide. Cuticle aspinose; eye-spot pigment present. Oral sucker 0.098-0.180 long, 0.153-0.200 wide; ventral sucker preequatorial, 0.195-0.300 long, 0.180-0.233 wide, with elongated aperture but no posterolateral lobes; sucker ratio 1:1.35-1.48. Prepharynx short; pharynx 0.060-0.090 in diameter; esophagus short; cecum extending to midlevel of ovary. Gonads postequatorial. Testis entire, at about midlevel of hindbody, 0.200-0.267 long, 0.167-0.200 wide. Seminal vesicle bipartite; long tubular posterior portion extending to about midlevel of ovary; thick-walled anterior division with conspicuous circular muscles and 2 large nuclei on inner surface, protruding into lumen; pars prostatica difficult to interpret; possibly part of a narrow tube leaving muscular portion of seminal vesicle or within conspicuous mass filling genital atrium and probably corresponding to what has been called genital

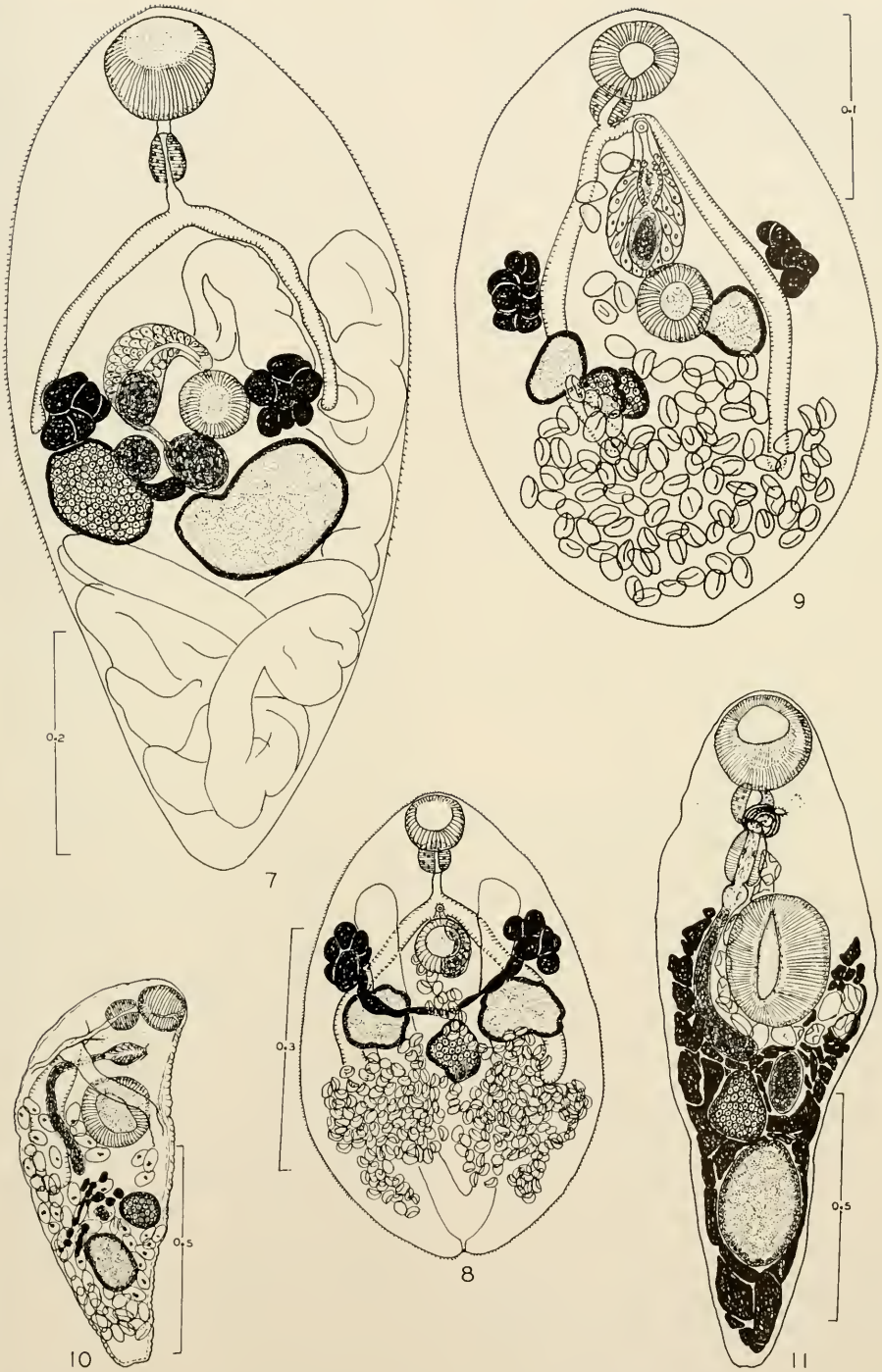


Figure 7. *Infundibulostomum anisotremi*, holotype, dorsal view. **Figure 8.** *Pseudobacciger manteri*, holotype, ventral view. **Figure 9.** *Bacciger opisthonemae*, holotype, ventral view. **Figure 10.** *Haplosplanchnus mugilis*, holotype, ventrolateral view. **Figure 11.** *Schikhobalotrema bivesicula*, holotype, ventral view.

bulb; prostate cells inconspicuous. Ovary entire or slightly irregular, 0.120-0.140 long, 0.078-0.105 wide; anterior to testis; seminal receptacle dorsolateral to ovary; uterus preovarian. Genital pore median, at pharyngeal level. Eggs few, 60-78 by 40-53 μ. Vitellaria of large follicles extending from anterior margin of ventral sucker to near posterior end of body. Excretory vesicle not observed; excretory pore terminal.

Schikhobalotrema bivesiculum differs from all other species of the genus in its conspicuous bipartite seminal vesicle. It resembles *S. acutum* and *S. adacutum* in general topography and although it has a longitudinal aperture in the acetabulum as in those species, the sucker lacks posterolateral lobes. The bipartite seminal vesicle with a thick anterior division in this species may be of generic value but the species is placed in *Schikhobalotrema* because others showing gradations in that respect may exist.

Schikhobalotrema **elongatum** n.sp.

Figure 12

Hosts: Mugil cephalus (C); *M. curema* (J).

Site: intestine.

Holotype: U.S.N.M. 60261.

Description based on 20 specimens. Body elongated, 0.734-1.49 long, 0.200-0.367 wide, with prominant cuticular rings, especially, in hindbody. Eye-spot pigment present. Oral sucker 0.090-0.150 long, 0.105-0.180 wide; ventral sucker without lobes, in anterior third or fourth of body, 0.120-0.195 in diameter, aperture circular; sucker ratio 1:1-1.32. Prepharynx about half length of pharynx; pharynx 0.060-0.075 in diameter; esophagus about as long as pharynx; cecum extending to midlevel of testis. Gonads in posterior half of body. Testis usually elongated, median, 0.167-0.366 long, 0.098-0.174 wide; seminal vesicle tubular, reaching almost midway between acetabulum and ovary; prostate cells granular, conspicuous, their ducts forming a bulbous mass just posterior to muscular genital atrium. Genital pore median, near posterior edge of pharynx. Ovary entire, anterior to testis, 0.090-0.133 long, 0.060-0.090 wide, well removed from ventral sucker except in contracted specimens; seminal receptacle dorsal, near ovarian level; uterus preovarian. Eggs 60-84 by 42-54 μ. Vitelline follicles large, extending from pharyngeal level to posterior end of body, tending to fuse in hindbody. Excretory vesicle not observed; pore terminal.

The most distinctive features of *Schikhobalotrema elongatum* are its long hindbody with prominent cuticular rings, and its well-developed bulb of prostatic ducts. In body shape, *S. elongatum* is similar to several species. *S. acutum* and *S. adacutum* have a ventral sucker with a longitudinal aperture and lateral lobes. *S. obtusum* lacks a prostatic vesicle; the genital atrium is nonmuscular and the ovary close to the acetabulum. *S. pomacentri* has an equatorial ventral sucker and *S. kyphosi* (Manter, 1947) a lobed ovary. *S. girellae* (Manter & Van Cleave, 1951) is most like *S. elongatum* but differs from that species in the extent of the seminal vesicle, in having a long tubular genital atrium and a more anterior ovary. *S. manteri* Siddiqi & Cable, 1960, differs in the distribution of the vitellaria, position of the testis and posterior extent of the uterus. *S. robustum* Pritchard & Manter, 1961, is much larger, has a thin-walled genital atrium and the genital pore on a finger-like projection.

Schikhobalotrema **heterocotylum** n.sp.

Figure 13

Host: Pseudoscarus guacamaia (C).

Site: intestine.

Holotype: U.S.N.M. 60262.

Description based on 5 specimens. Body subspherical to pyriform, 1.29-1.50 long, 0.869-0.965 wide. Cuticle thick, aspinose; eye-spot pigment present. Oral sucker 0.128-0.186 long, 0.233-0.266 wide, ventral lip with papilla bearing openings of salivary gland in forebody. Ventral sucker at midbody, 0.466-0.533 long, 0.533-0.613 wide, its interior with 2 anterior and 2 posterior tuberculated projections. Sucker ratio 1:2.6-2.8. Prepharynx short; pharynx 0.130-0.150 long, 0.105-0.135 wide; esophagus short; cecum extending to midlevel of acetabulum. Gonads in posterior third of body. Testis 0.386-0.486 long, 0.213-0.333 wide, to right of midline; seminal vesicle long, extending to posterior level of ventral sucker or slightly beyond; pars prostatica small, inconspicuous. Ovary entire to slightly lobed, 0.133-0.180 long, 0.098-0.135 wide, median, posterior to acetabulum; seminal receptacle postovarian and much larger than ovary; uterus pre-

ovarian. Genital pore ventral, near midlevel of pharynx. Eggs 84-99 by 53-75 μ. Vitelline follicles numerous, extending from midlevel of pharynx to posterior end of body. Excretory vesicle not observed.

No haplosplanchnid has been described as having an acetabulum with the tuberculated lobes characteristic of this species. Most like it in other respects is *S. brachyurum* (Manter, 1937) a paratype of which we have examined and found to lack such lobes. It further differs from *S. heterocotylum* in having a different body shape, a smaller ventral sucker and a different sucker ratio. Although similar in body shape, *S. glomerosum* Pritchard and Manter, 1961, has a smaller ventral sucker, a preacetabular ovary, more anterior testis and a well-developed metraterm.

The next species has haplosplanchnid characteristics but differs from known genera in having the ventral sucker so near the posterior end of the body that the gonads necessarily are preacetabular. In life, that sucker was nearer the posterior end of the body in our specimen than it appears in the whole mount (Fig. 14). Thus the Haplosplanchnidae is another example of families in which certain species evidently are secondarily amphistomatous. To receive the species, a new genus is erected and characterized as follows:

Haplosplanchnoides n.g.

Diagnosis: Family Haplosplanchnidae. Body with thick unarmed cuticle. Oral sucker terminal; ventral sucker near posterior end of body. Prepharynx and pharynx present; cecum single, extending to posterior end of body. Testis single, anterior to acetabulum; cirrus sac absent; seminal vesicle long and tubular. Ovary anterior to testis; seminal receptacle present; uterus pretesticular. Genital pore in anterior half of body. Vitellaria extensive, from prepharyngeal level to posterior end of body. Eggs large. Parasites in intestine of marine fishes. Type and only species:

Haplosplanchnoides hemiramphi n.g., n.sp.

Figure 14

Host: Hemiramphus brasiliensis (J).
Site: intestine.
Holotype: U.S.N.M. 60263.

Description based on a single specimen. Body elongated, rounded at both ends, 1.73 long by 0.720 wide. Oral sucker 0.233 long, 0.267 wide; ventral sucker near posterior end of body, 0.420 long, 0.313 deep; ratio of sucker lengths 1:1.7. Prepharynx short; pharynx 0.133 long, 0.160 wide; cecum long, terminating near posterior end of body. Testis entire, 0.188 by 0.210, near anterior margin of ventral sucker; seminal vesicle long, sinuous, extending from genital pore to testis; pars prostatica and prostate cells not seen, probably obscured by vitelline follicles; ejaculatory duct short. Ovary entire, 0.153 by 0.158, a short distance anterior to testis; seminal receptacle anterodorsal to ovary; uterus short. Genital pore probably median, about midway between ovary and pharynx. Vitelline follicles large, filling most of body between prepharynx and posterior end. Eggs few, 75-84 by 60-68 μ. Excretory vesicle not observed; pore dorsal, a short distance from posterior end of body.

Although certain other haplosplanchnids have short hindbodies, their gonads are never anterior to the acetabulum except perhaps in *Schikhobalotrema glomerosum* which Pritchard and Manter (1961) described from two specimens in poor condition.

FAMILY MEGAPERIDAE Manter, 1934

Thysanopharynx elongatus Manter, 1933
Host: Lactophrys bicaudalis (C).
Site: intestine.

Megapera gyrina (Linton, 1907) Manter, 1934

Synonyms: Distomum gyrinus Linton, 1907; *Eurypera gyrina* (Linton) Manter, 1933.

Hosts: Lactophrys bicaudalis (C); *L. tricornis* (J); **L. triqueter* (C).
Site: intestine.

Megapera **pseudogyrina** n.sp.

Figure 15

Host: Cantherines pullus (J).
Site: intestine.
Holotype: U.S.N.M. 60264.

Description based on 17 specimens. Body 0.667-1.60 long, greatest width 0.246-0.506, in forebody, gradually tapering towards posterior end; sides sometimes incurved posterior to testes; anterior end broadly rounded. Cuticular spines extremely fine, not extending posterior to testes; eye-spot pigment present. Oral sucker 0.150-0.333 long, 0.165-

0.400 wide, with histology peculiar to the family; ventral sucker 0.060-0.100 in diameter, near junction of first and second thirds of body length; sucker ratio 1:0.3-0.45. Pharynx 0.045-0.090 long, 0.130-0.150 wide with lobed anterior border; esophagus absent; ceca long and wide, opening separately through ani at posterior end of body. Testes 2, elongated, 0.120-0.333 long, 0.060-0.166 wide, symmetrical, extending posterolaterally from pharynx to about posterior level of ventral sucker, overlapping cecal arch. Seminal vesicle free in parenchyma, spherical, sometimes larger than ventral sucker, usually extending posterior to it; pars prostatica dorsal to genital atrium, small, spherical, surrounded by prostate cells. Ovary indented to trilobed, 0.053-0.150 long, 0.045-0.080 wide; seminal receptacle anterodorsal to ovary; uterus short, mostly preovarian. Genital pore median, immediately preacetabular. Vitelline follicles elongated, in two ventrolateral groups extending from near testes to posterior end of body, and 2 dorsal groups usually enmeshed in midline, extending from posterior margin of ovary to near posterior end of body. Eggs thin-shelled 48-53 by 31-33 μ. Excretory vesicle tubular as far as ovarian level.

This species is most like *Megapera gyrina* (Linton, 1907) but differs from it chiefly in body shape and the form and distribution of the vitellaria. Posterior to the testes the body tapers gradually or is moderately incurved instead of narrowing abruptly and becoming tail-like as in *M. gyrina*. Although the vitelline follicles of *M. pseudogyrina* are elongated, they are by no means as narrow, uniformly shaped, or as numerous as in *M. gyrina*.

Superorder *Epitheliocystidia* La Rue, 1957
Order *Plagiorchiida* La Rue, 1957
Suborder *Plagiorchiata* La Rue, 1957
Superfamily *Plagiorchioidea* Dollfus, 1930
FAMILY MICROPHALLIDAE Travassos, 1921

Carneophallus lactophrysi Siddiqi & Cable, 1960

Hosts: **Myrichthys acuminatus* (C); **M. oculatus* (C).
Site: intestine.

Although this species was a common parasite of eels of the genus *Myrichthys* in Curaçao, it was not found there in the trunk fish which is the type host in Puerto Rico.

Microphallus excellens (Nicoll, 1907) Baer, 1943

Synonym: Spelotrema excellens Nicoll, 1907.
Host: **Myrichthys oculatus* (C).
Site: intestine.

Fifteen worms from a single host are identified as *M. excellens* using Baer's (1943) key and that of Biguet, Deblock and Capron (1958). They differ, however, from Nicoll's specimens in being smaller (0.547-0.781 compared with 0.71-1.39) and also in having relatively larger suckers and pharynx. Belopolskaja in *Skrjabin* (1952) considers *Spelotrema feriatum* Nicoll, 1907, a synonym of *S. excellens*. The present material falls within the combined range of measurements given under those names.

A species of *Microphallus* has not hitherto been reported from a marine fish.

Superfamily *Lepocreadioidea* Cable, 1956
FAMILY LEPOCREADIIDAE Nicoll, 1934

Homalometron elongatum Manter, 1947
Host: Gerres cinereus (J).
Site: intestine.

Homalometron foliatum Siddiqi & Cable 1960

Hosts: Haemulon album (C); *H. flavolineatum* (C, J); **H. sciurus* (J); **Lutianus mahogoni* (C); **Brachygenys chrysargyreus* (C).
Site: intestine.

Thirty individuals of this species agree with the original description except that the body length is up to 3.956, the sucker ratio ranges from 1:0.70-1.03, the vitellaria may reach the anterior margin of the ovary, and egg size is 66-90 by 45-60 μ.

Crassicutis marina Manter, 1947
Host: Gerres cinereus (J).
Site: intestine.

Crassicutis **gerridis** n.sp.
Figure 16

Host: Gerres cinereus (C, J).
Site: intestine.
Holotype: U.S.N.M. 60265.

Description based on 15 specimens. Body elongated, 1.04-2.6 long, 0.400-0.710 wide.

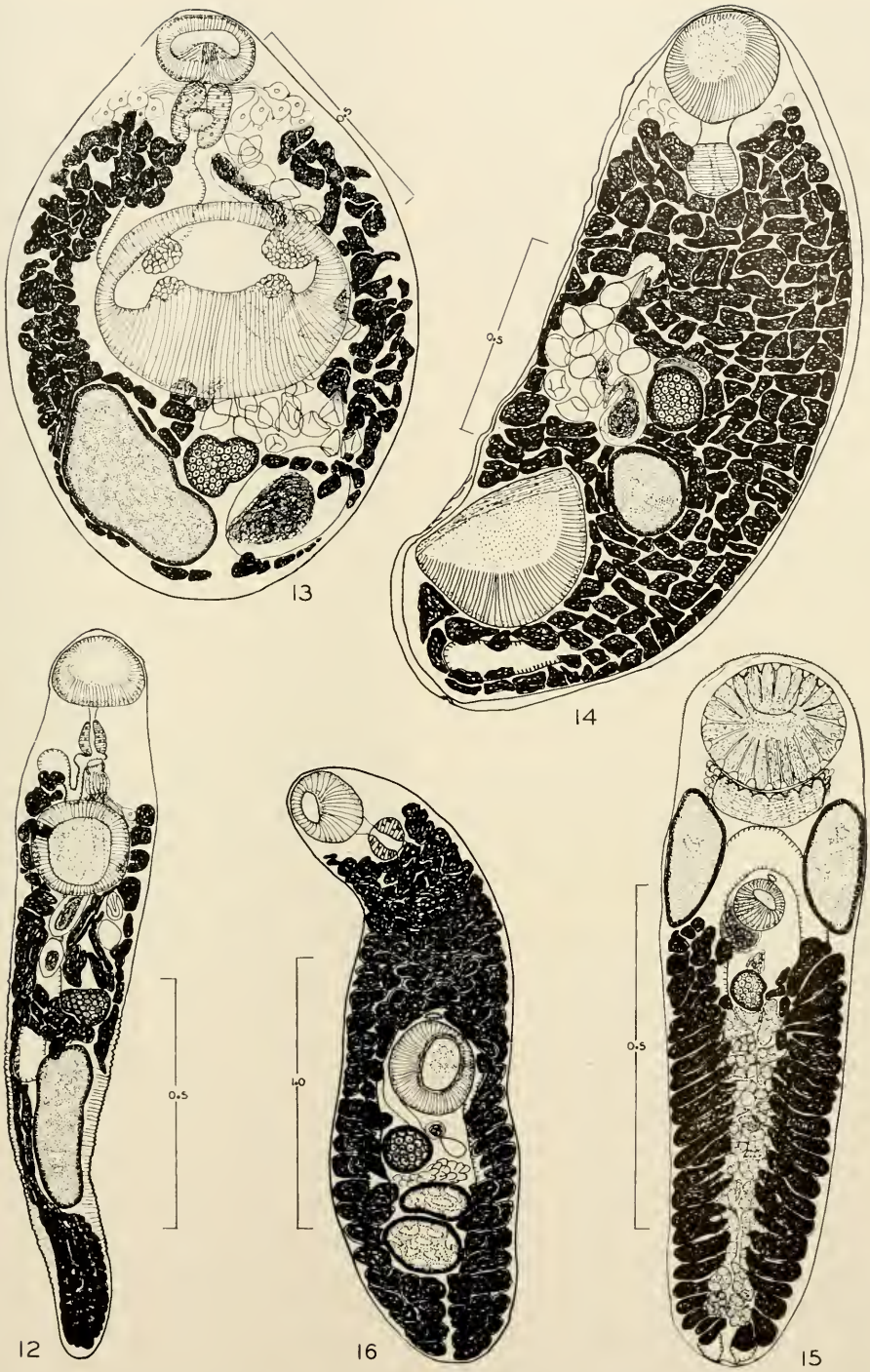


Figure 12. *Schikhobalotrema elongata,* holotype, ventral view. **Figure 13.** *Schikhobalotrema heterocotyla,* holotype, ventral view. **Figure 14.** *Haplosplanchnoides hemiramphi,* holotype, ventrolateral view. **Figure 15.** *Megapera pseudogyrina,* holotype, ventral view. **Figure 16.** *Crassicutis gerridis,* holotype, ventral view.

Long, very narrow, widely spaced spines imbedded in thick cuticle of larger specimens but not of immature ones. Eye-spot pigment present. Oral sucker 0.173-0.280 in diameter; ventral sucker equatorial, 0.206-0.400 long, 0.267-0.333 wide; sucker ratio 1:1.13-1.43. Prepharynx about 3/4 length of pharynx; pharynx 0.055-0.105 long, 0.075-0.114 wide; esophagus shorter than pharynx, intestinal bifurcation well anterior to ventral sucker; ceca long, extending almost to posterior end of body. Testes tandem, close together, 0.100-0.300 long, 0.180-0.333 wide; posttesticular space 1/6-1/8 body length. Cirrus sac absent; ejaculatory duct relatively long, opening into indistinct genital atrium; pars prostatica small, with indistinct prostate cells; seminal vesicle saccular, extending to or slightly beyond posterior edge of ventral sucker. Genital pore small, median, immediately anterior to ventral sucker. Ovary smooth, 0.100-0.233 in diameter, separated from anterior testis by Mehlis' gland; seminal receptacle small, inconspicuous, antero- or laterodorsal to ovary; Laurer's canal opens dorsally, median to ovary; uterus pretesticular; metraterm not observed. Vitellaria of large follicles extending from posterior edge of oral sucker or pharynx to posterior end of body, occupying all available space between ventral sucker and pharynx. Eggs 83-113 by 46-60 μ. Excretory vesicle short, sac-shaped, not quite reaching posterior testis.

Three species of *Crassicutis* have been described. *C. cichlasomae* Manter, 1936, from a fresh-water host, *C. marina* Manter, 1947, and *C. archosargi* Sparks & Thatcher, 1960. *C. gerridis* differs from all 3 in having a long forebody filled with vitelline follicles. In addition it differs from *C. cichlasomae* in habitat and in having tandem rather than diagonal testes. It differs from *C. archosargi* in the position of the ventral sucker and position of the gonads. *C. marina*, described from the same host in Florida and also found in this study, differs from *C. gerridis* chiefly in having a more anterior ventral sucker and much less extensive preacetabular vitellaria, differences observed in living specimens as well as whole mounts; other possible differences are the less conspicuous seminal vesicle and seminal receptacle in *C. gerridis*.

Lepidapedon trachinoti Hanson, 1950

Hosts: **Epinephelus morio* (C); *E. Striatus* (C).

Site: ceca.

The most distinctive feature of this species is the lateral depression at the left margin of the body opposite the genital pore. Our specimens agree with Hanson's description except for a slightly larger size (up to 3.76 long by 0.594 wide) and an entire rather than irregular ovary.

Lepidapedon truncatum Sogandares-Bernal, 1959

Synonym: ***Lepidapedon holocentri* Siddiqi & Cable, 1960.

Host: Holocentrus ascensionis (C, J).

Site: ceca and upper intestine.

Lepidapedon holocentri is obviously a synonym of *L. truncatum*. The descriptions of both were in press at the same time.

Neolepidapedon mycteropercae Siddiqi & Cable, 1960

Hosts: **Mycteroperca bonaci* (C); **M. venonosa* (C).

Site: intestine.

Fifty-five specimens are in general agreement with the original description of the species, based on a single specimen, but show certain variations. The vitellaria may or may not be confluent between the gonads and may reach the midlevel of the external seminal vesicle. The metraterm is muscular, the genital pore is usually posterolateral to acetabulum but may be near its midlevel. The sucker ratio is 1:1.38-1.48 and eggs measure up to 62 μ in length.

Neolepidapedon **hypoplectri** n.sp.

Figure 17

Host: Hypoplectrus unicolor (J).

Site: intestine.

Holotype: U.S.N.M. 60266.

Description based on 13 specimens. Body elongated, 1.35-2.02 long, 0.280-0.380 wide. Entire cuticle spinose; eye-spot pigment present. Oral sucker 0.090-0.112 in diameter; ventral sucker 0.063-0.083 in diameter; sucker ratio 1:0.70-0.76. Prepharynx very short; pharynx 0.033-0.054 in diameter; esophagus 2-3 times length of pharynx; intestinal bifurcation about midway between suckers; ceca extending to near posterior end of body. Testes 2, entire, 0.068-0.135

long, 0.090-0.150 wide, tandem, not close together. Cirrus sac extending well posterior to ventral sucker, containing small spherical internal seminal vesicle, large conspicuous pars prostatica and cirrus; external seminal vesicle tubular, sinuous, surrounded by prostatic cells along most of its length and extending about halfway from ventral sucker to ovary. Ovary entire, smooth, pretesticular, 0.063-0.098 long, 0.080-0.105 wide, seminal receptacle postovarian; uterus preovarian; metraterm about same length as cirrus sac. Genital atrium small; genital pore sinistral, at about midlevel of ventral sucker. Eggs 45-60 by 28-33 μ. Vitelline follicles in lateral fields, from about end of cirrus sac to posterior end of body; confluent in posttesticular space, usually between testes, rarely between ovary and anterior testis. Excretory vesicle tubular, extending to intestinal bifurcation; sphincter well developed, pore terminal.

The excretory vesicle is known to terminate between the anterior margin of the acetabulum and the intestinal bifurcation in 3 species of *Neolepidapedon* besides *N. hypoplectri: N. medialunae* Montgomery, 1957, *N. epinepheli* Siddiqi & Cable, 1960, and *N. mycteropercae* Siddiqi & Cable, 1960. The anterior extent of the vesicle is not described for *N. cablei* Manter, 1954, and *N. retrusum* (Linton, 1940). In all other species reported to date, it reaches only to the anterior testis or ovary. *N. hypoplectrus* differs from *N. cablei* chiefly in lacking the preacetabular, glandular hump-like protuberance, in sucker ratio and position of the acetabulum; from *N. retrusum* and *N. mycteropercae* in sucker ratio; from *N. epinepheli* in the anterior extent of the vitellaria, position of the genital pore and in having a smaller pharynx and narrow eggs; and from *N. medialunae* in position of the ventral sucker, extent of spination, shape of oral sucker and in having a shorter prepharynx and esophagus.

Multitestis inconstans (Linton, 1905) Manter, 1931

Synonym: Distomum inconstans Linton, 1905.

Host: Chaetodipterus faber (J).

Site: intestine.

Multitestis blenni Manter, 1931

Host: Chaetodipterus faber (J).

Site: intestine.

Multitestis chaetodoni Manter, 1947

Synonym: Distomum sp. of Linton, 1907, p. 115.

Hosts: Chaetodon capistratus (J); *C. striatus* (J).

Site: ceca and intestine.

It is of interest to note that none of the *Chaetodon* species examined in Curaçao harbored *M. chaetodoni.* It seeems to be replaced there by the next species, at least in *C. capistratus.*

Multitestis rotundus Sparks, 1954

*Hosts: *Archosargus unimaculatus* (J); **Chaetodon capistratus* (C, J).

Site: intestine.

Our specimens actually agree more with those of Sogandares-Bernal and Hutton (1959b) than with the species as originally described. The vitellaria extend anteriorly as far as the pharyngeal level and sometimes to the oral sucker; the follicles may or may not be confluent posteriorly.

Opechona **chloroscombri** n.sp.

Figure 18

Synonym: Opechona sp. Siddiqi & Cable, 1960.

Host: Chloroscombrus chrysurus (J).

Site: intestine.

Holotype: U.S.N.M. 60267.

Description based on 12 mature specimens. Body elongated, rounded at both ends, 1.06-1.50 long, 0.220-0.300 wide. Entire cuticle spinose; eye-spot pigment present. Oral sucker 0.039-0.053 in diameter; ventral sucker in anterior region of mid-third of body, 0.055-0.068 long, 0.063-0.084 wide; sucker ratio 1:1.4-1.5. Prepharynx 0.030-0.098 long; pharynx 0.048-0.060 long, 0.033-0.042 wide; esophagus 0.180-0.255 long, including a posterior glandular portion (pseudesophagus) measuring 0.105-0.150 in length; ceca extend to near posterior end of body. Testes 0.068-0.100 in diameter, tandem, close together, in posterior third of body; posttesticular space 1/5-1/4 body length. Cirrus sac long, extending to about midway between acetabulum and ovary, containing small spherical internal seminal vesicle, larger pars prostatica and long cirrus; external seminal vesicle tubular, about half length of cirrus sac. Ovary entire, 0.045-0.054 long, 0.053-0.078 wide; seminal receptacle between ovary and anterior testis;

uterus preovarian; metraterm about same length as cirrus; genital pore slightly sinistral, about midway between acetabulum and intestinal bifurcation. Vitelline follicles extending from level of ventral sucker to posterior end of body, not confluent posterior to testes. Opaque eggs 45-53 by 30-36 μ. Excretory vesicle, thick-walled (epithelial), varying in anterior extent from anterior margin of acetabulum to intestinal bifuraction.

Opechona chloroscombri is most similar to *O. gracilis* (Linton, 1910) in the extent of the vitellaria and length of the excretory vesicle but differs from that species in size and ratio of suckers and the ratio of pseudesophagus to esophagus.

Opechona **sardinellae** n.sp.

Figure 19

Host: Sardinella macrophthalmus (J).
Site: intestine.
Holotype: U.S.N.M. 60268.

Description based on 9 specimens. Body 1.03-1.158 long, 0.286-0.536 in maximum width near testicular level, tapering toward anterior end; posterior extremity rounded, usually with indentation at excretory pore. Cuticle spinose, spines extending only to about intestinal bifurcation; eye-spot pigment present. Oral sucker 0.075-0.135 long, 0.105-0.150 wide; ventral sucker somewhat preequatorial, 0.066-0.113 in diameter; sucker ratio 1:0.7-0.8. Prepharynx short, pharynx massive, 0.090-0.150 in diameter; esophagus about same length as pharynx, its epithelial region (pseudesophagus) almost as long as simple anterior portion; ceca wide, reaching midway between testes and posterior end of body. Testes tandem, 0.075-0.153 long, 0.098-0.160 wide, in posterior third of body; cirrus sac extending to about midway between acetabulum and ovary, containing small internal seminal vesicle, pars prostatica which is sometimes indistinctly bipartite, and cirrus. External seminal vesicle tubular, about 2/3 length of cirrus sac. Ovary entire, 0.055-0.100 long, 0.080-0.114 wide, separated from anterior testis by seminal receptacle and vitelline reservoir; uterus pretesticular, terminating in short, muscular metraterm. Genital pore sinistral, midway between ventral sucker and intestinal bifurcation. Vitelline follicles extending from level of acetabulum to posterior end of body, rarely confluent behind testes. Eggs 58-68 by 35-45 μ. Excretory vesicle tubular, sigmoid in living specimens, crossing left cecum ventrally and extending to midlevel of pharynx; excretory pore terminal, with sphincter.

Species of *Opechona* with the extent of vitellaria and excretory vesicle more or less as in *O. sardinellae* are: *O. orientalis* (Layman, 1930) and *O. pharyngodactyla* Manter, 1940. *O. sardinellae* differs from *O. orientalis* chiefly in shape of ovary and oral sucker and in having a shorter prepharynx and esophagus, and from *O. pharyngodactyla* in lacking the finger-like projections on the pharynx and in sucker ratio. *Opechona gracilis* reported by Linton (1910) from *Clupanodon pseudohispanicus* and by Manter (1947) from *Harengula (Sardinella) macrophthalmus* is distinguished from *O. sardinellae* by extent of body spination, sucker ratio, proportion of pseudesophagus to the esophagus, size of pharynx and length of the excretory vesicle which was reported by Manter to extend only to the acetabulum. *Opechona sardinellae* differs from *O. chloroscombri* in body shape and spination, size and ratio of suckers, and length of excretory vesicle and esophagus.

Lepocreadium bimarinum Manter, 1940
Host: **Bodianus rufa* (J).
Site: intestine.

Lepocreadium trulla (Linton, 1907) Linton, 1910
Synonym: Distomum trulla Linton, 1907.
Host: Ocyurus chrysurus (C, J).
Site: intestine.

Lepocreadium pyriforme (Linton, 1900) Linton, 1940
Synonym: Distomum pyriforme Linton, 1900.
Host: Peprilus paru (J).
Site: intestine.

Linton (1940) reported as this species trematodes from 9 hosts including *Peprilus paru.* We doubt that all of them are the same species. Our single specimen lacks eggs but otherwise agrees with Linton's description and is referred to *L. pyriforme* on the basis of its similarity to his Figure 47 of a specimen from *Palinurichthys perciformis,* the type host of *L. pyriforme.*

Lepocreadium opsanusi Sogandares-Bernal & Hutton, 1960

Hosts: **Calamus arctifrons* (J); **C. bajanado* (J).

Site: ceca and intestine.

In the extent and distribution of vitellaria, position of gonads, extent of the excretory vesicle and general topography, our numerous specimens are most like ones which Sogandares-Bernal and Hutton (1960) named provisionally as *Lepocreadium opsanusi.* In the Jamaican specimens, the body is somewhat smaller (0.346-0.586 long, 0.185-0.253 wide) as are the eggs (54-62 by 33-38 μ) and the sucker ratio is 1:0.83-1.00 whereas Sogandares-Bernal and Hutton gave a ratio of 1:1-1.85. However, their drawing of the holotype shows an acetabulum that is smaller than the oral sucker as is true of most of our specimens.

Lepocreadium **hemiramphi** n.sp.

Figure 20

Host: Hemiramphus brasiliensis (C).

Site: intestine.

Holotype: U.S.N.M. 60269.

Description based on 25 specimens. Body from pyriform to more elongated with bluntly pointed posterior end, 0.286-0.513 long, 0.160-0.200 wide. Entire cuticle spinose; eye-spot pigment present. Oral sucker 0.039-0.055 in diameter; ventral sucker in middle third of body, 0.037-0.060 in diameter; sucker ratio 1:0.91-1.00. Pharynx 0.036-0.045 long, 0.030-0.033 wide; prepharynx and esophagus about as long as pharynx; intestinal bifurcation close to acetabulum; ceca extend almost to posterior end of body. Testes 2, entire, tandem, near posterior end of body, 0.030-0.060 in diameter; cirrus sac about 1/5 body length, reaching ovarian zone, usually ovoid, containing spherical internal seminal vesicle, prominent pars prostatica and long, winding cirrus; external seminal vesicle large, spherical. Genital atrium small; genital pore anterosinistral to acetabulum. Ovary entire, median, 0.027-0.039 long, 0.030-0.048 wide; seminal receptacle postovarian; uterus short, preovarian, terminating in conspicuous, thick-walled metraterm. Eggs few (no more than 2 observed in uterus of any one worm), 45-57 by 30-37 μ. Vitelline follicles extending from esophageal level almost to posterior end of body, slightly if at all overreaching posterior testis. Excretory vesicle tubular, its anterior extent not determined; excretory pore terminal.

Lepocreadium hemiramphi is most similar to *L. floridanum* Sogandares-Bernal and Hutton, 1959 and *L. pyriforme* (Linton, 1900). It differs from both in being much smaller and more compact with the cirrus sac reaching the ovary, and in having the testes nearer the posterior end and the vitellaria extend farther anteriorly but not appreciably posterior to the testes.

Lepocreadium **truncatum** n.sp.

Figure 21

Synonym: Lepocreadium sp. Siddiqi & Cable, 1960.

Host: Ocyurus chrysurus (C).

Site: intestine.

Holotype: U.S.N.M. 60270.

Description based on 4 specimens (1 from Curaçao and 3 from Puerto Rico). Body 0.467-0.714 long, 0.293-0.393 wide, pyriform, tapering anteriorly, truncated posteriorly. Entire cuticle spinose, spines becoming sparse posteriorly; eye-spot pigment present. Oral sucker 0.053-0.075 long, 0.060-0.090 wide; ventral sucker 0.099-0.120 in diameter; sucker ratio 1:1.3-1.55. Prepharynx present; pharynx 0.045-0.060 in diameter; esophagus short; intestinal bifurcation about midway between suckers; ceca extending to posterior end of body. Testes 2, entire, tandem, 0.042-0.083 long, 0.105-0.150 wide; cirrus sac extending midway from acetabulum to ovary, containing spherical internal seminal vesicle, well developed prostatic complex and thick cirrus; external seminal vesicle saccate. Ovary 0.068-0.083 long, 0.030-0.068 wide, trilobed, to right of median line; seminal receptacle present; uterus pretesticular; metraterm distinct. Genital pore about midway between ventral sucker and intestinal bifurcation. Eggs few, 53-60 by 28-33 μ. Vitelline follicles large, extending from anterior level of ventral sucker to posterior end of body. Excretory vesicle tubular, anterior extent not determined; pore terminal.

This species is most like *L. trulla* (Linton, 1907) and *L. maris* (Caballero, 1957) but differs from them chiefly in sucker ratio and in having tandem rather than diagonal testes.

Apocreadium balistis Manter, 1947
Host: Balistes vetula (J).
Site: intestine.

Of 3 specimens, one of which was immature, none shows ridges on the testes.

Apocreadium mexicanum Manter, 1937
*Host: *Monacanthus hispidus* (J).
Site: intestine.

Our many specimens are more like those of Siddiqi and Cable (1960) from Puerto Rico than the species as originally described. The posttesticular space usually is less than half as long as the body but sometimes the 2 regions are about equal in length. Opaque eggs measure 63-71 by 42-45 μ, collapsed ones are 30-40 μ wide. The anterior limit of the vitellaria varies between the posterior and anterior margins of the ventral sucker.

Neoapocreadium coili (Sogandares-Bernal, 1959) Siddiqi & Cable, 1960
Synonym: Apocreadium coili Sogandares-Bernal, 1959.
Host: Balistes vetula (J).
Site: intestine.

Neoapocreadium angustum (Sogandares-Bernal, 1959) Siddiqi & Cable, 1960
Synonym: Apocreadium angustum Sogandares-Bernal, 1959.
Host: Lactophrys trigonus (C).
Site: intestine.

Postporus epinepheli (Manter, 1947) Manter, 1949
Synonyms: Opisthoporus epinepheli Manter, 1947; *Postporus mycteropercae* (Manter) Manter, 1949.
Hosts: Epinephelus adscensionis (C, J); *E. guttatus* (C); *E. morio* (C); *E. striatus* (C, J).
Site: intestine.

The variations observed in this species by Siddiqi and Cable (1960) are confirmed. The sucker ratio is 1:0.61-0.97 except for one of 1:0.53 in a single, apparently excessively flattened specimen from *Epinephelus striatus.*

Myzoxenus lachnolaimi Manter, 1947
Host: Lachnolaimus maximus (J).
Site: intestine.

Rhagorchis odhneri Manter, 1931
Synonym: Gargorchis varians Linton, 1940.
Host: Alutera schoepfii (J).
Site: intestine.

Manter (1931) described the excretory vesicle as being tubular but in our living specimens it was distinctly Y-shaped, bifurcating dorsal to the ventral sucker to form voluminous arms extending to the sides of the pharynx. The main excretory tubules evidently leave the stem of the vesicle and divide into anterior and posterior tubules before reaching the acetabular level.

Cadenatella **kyphosi** n.sp.
Figures 22 and 23
Host: Kyphosus sectatrix (C).
Site: intestine.
Holotype: U.S.N.M. 60271.

Description based on 13 specimens; measurements on 8 mature ones. Body elongated, 2.3-4.15 long, 0.267-0.366 wide. Cuticle spinose from anterior end almost to ventral sucker dorsally, to level of testis ventrally. Eye-spot pigment present; brownish yellow pigment scattered through parenchyma. Forebody with 14-18 midventral accessory suckers; one, 2 or rarely 3 near anterior edge of pharynx, distinctly separated from others extending from near posterior edge of pharynx to acetabulum. Oral sucker with 8 muscular preoral lobes, rather uniform in length, in a dorsal and a ventral row of 4 each; lobes not subdivided or prominently extended in either living or fixed and stained specimens; sucker 0.133-0.166 long including lobes, 0.107-0.140 wide. Ventral sucker in anterior fourth of body, 0.146-0.200 in diameter; sucker ratio 1:1.14-1.40. Prepharynx wide, about same length as pharynx; pharynx massive, pyriform, 0.150-0.220 long, 0.107-0.155 wide; esophagus very short, ceca extending to posterior end of body, joining excretory vesicle to form uroproct with terminal pore. Single testis elongated, 0.333-0.446 long, 0.127-0.167 wide, about 1/3 body length from posterior end. Cirrus sac absent; seminal vesicle long, sinuous, extending about halfway from ventral sucker to ovary; pars prostatica ovoid, near anterior edge of acetabulum; ejaculatory duct short. Genital atrium inconspicuous, genital pore midventral, immediately anterior to ventral sucker. Ovary entire, 0.080-0.133 long, 0.106-0.140 wide, anterior to testis, separated from it by vitelline reservoir; seminal receptacle of uterine type, anterior to ovary;

Figure 17. *Neolepidapedon hypoplectri*, holotype, ventral view. **Figure 18.** *Opechona chloroscombri*, holotype, ventral view. **Figure 19.** *Opechona sardinellae*, holotype, dorsal view. **Figure 20.** *Lepocreadium hemiramphi*, holotype, ventral view. **Figure 21.** *Lepocreadium truncatum*, holotype, dorsal view. **Figure 22.** *Cadenatella kyphosi*, holotype, ventral view. **Figure 23.** Same, oral sucker from dorsal aspect, drawn free-hand from living specimen.

Mehlis' gland near receptacle; Laurer's canal present, opening dorsal to ovary; uterus preovarian, intercecal; metraterm absent. Eggs broadly lunate, 48-68 by 22-30, usually 52-63 by 24-28 μ. Vitelline follicles numerous, extending from posterior third of testis to end of body. Excretory vesicle Y-shaped, its stem bifurcating at ovarian level to form wide arms extending to about midway between ovary and ventral sucker; excretory canals leave tips of arms to extend to sides of oral sucker and turn posteriorly, receiving first branch at prepharyngeal level; flame cells numerous. Lymphatic channels not evident but a number of ventral glands on each side of forebody have ducts in a bundle accompanying excretory canals with some at least opening at anterior end of body.

This species represents a peculiar group of trematodes known only from chubs of the genus *Kyphosus*. Uncertainty as to its affinities was mentioned earlier in this paper in connection with the Superfamily Haploporoidea. Generic concepts within the group remain to be clarified.

Dollfus (1946) described 3 species from *Kyphosus sectatrix* in Senegal and allocated each to a new subgenus in the genus *Enenterum*, naming them *E. (Enenterum) pseudaureum*, *E. (Cadenatella) cadenati* and *E. (Jeancadenatia) brumpti*. The subgenus *Enenterum* had 10 oral lobes, no accessory suckers, and 2 testes; *Cadenatella* had 8 oral lobes, one accessory sucker and one testis; and *Jeancadenatia* had 10 oral lobes, numerous accessory suckers, and probably one testis which Dollfus misinterpreted as 2 in his macerated specimens. Nagaty (1948) followed Manter's (1947) suggestion and raised the subgenera to generic rank.

Winter (1957) described *Jeancadenatia dohenyi* from *Kyphosus elegans* in the Mexican Pacific; it has 10 oral lobes, one testis, and only 2 accessory suckers. Sogandares-Bernal (1959) identified as *J. brumpti* 2 specimens from *K. sectatrix* at Bimini, each with but one testis. Manter (1949) described *Cadenatella americana* as having a cirrus sac but reexamination of the holotype reveals that the pars prostatica probably was misinterpreted as a cirrus sac. The presence of accessory suckers and absence of a cirrus sac seems to be correlated in these trematodes, as in the opecoelids.

We believe that the presence of accessory suckers is a generic character whereas their number distinguishes species; the same is concluded for the oral lobes some of which may be more or less distinctly subdivided in some species and not in others. *Jeancadenatia* thus is considered a synonym of *Cadenatella* which has page priority. It includes the following species:

C. cadenati Dollfus, 1946, type species
C. americana Manter, 1949
C. brumpti (Dollfus, 1946) n.comb.
Syn. *Enenterum (Jeancadenatia) brumpti* Dollfus
Jeancadenatia brumpti (Dollfus) Nagaty, 1948
C. dohenyi (Winter, 1957) n.comb.
Syn. *Jeancadenatia dohenyi* Winter
C. kyphosi n.sp.

Cadenatella kyphosi is most like *C. brumpti* but differs from that species in the arrangement of the accessory suckers; number size and shape of the oral lobes; shorter prepharynx; and smaller size.

Diploproctodaeum plicitum (Linton, 1928) Sogandares-Bernal & Hutton, 1958

Synonyms: Distomum sp. of Linton, 1898 and 1905; *Psilostomum plicitum* Linton, 1928; *Bianium concavum* Stunkard, 1930; *Bianium adplicitum* Manter, 1940; *Bianium plicitum* (Linton) Stunkard, 1931.

Hosts: Spheroides spengleri (J); **S. testudineus* (J).

Site: intestine.

Diploproctodaeum haustrum (MacCallum, 1919) La Rue, 1926

Synonyms: Hemistomum haustrum MacCallum, 1919; *Bianium lecanocephalum* Pérez Vigueras, 1955.

Host: **Cantherines pullus* (C, J).

Site: intestine.

The ovary in this species is variable. MacCallum (1919) and Pérez Vigueras (1955b) show an entire or subtriangular ovary. The majority of the specimens in our collection show the ovary in various degrees of lobulation with a maximum of 5 lobes. Dr. Sogandares (personal communication) confirmed this variation in his material from Bimini. In many specimens, a few vitelline follicles extend to the mid- or anterior level of acetabulum.

Diploproctodaeum **diodontis** n.sp.

Figure 24

Host: Diodon hystrix (J).

Site: intestine.

Holotype: U.S.N.M. 60272.

Description based on 10 mature specimens. Body discoid, ventral surface concave, inrolled at sides, 0.965-1.74 long, 0.887-1.39 wide. Entire cuticle spinose; eye-spot pigment present. Oral sucker well removed from anterior end of body, 0.135-0.200 long, 0.180-0.270 wide; ventral sucker equatorial to somewhat postequatorial, 0.180-0.266 in diameter; sucker ratio 1:1-1.2. Prepharynx absent; pharynx massive, 0.120-0.150 long, 0.140-0.195 wide, usually with 8 anterior lobes; esophagus absent; ceca wide, arching from pharynx and extending posteriorly to converge at sides of posterior testis where each opens dorsally at an anus far from posterior end of body. Testes usually diagonal, rarely tandem, 0.120-0.233 long, 0.080-0.150 wide; cirrus sac extending to near midlevel of ventral sucker, usually to left of that sucker but may be displaced to right, containing spherical internal seminal vesicle, pars prostatica of about same size, and cirrus; external seminal vesicle prominent. Ovary with 10-15 distinct lobes, to left of midline, usually opposite anterior testis but may be intertesticular; seminal receptacle antero- or laterodorsal to ovary; uterus short, pretesticular, terminating in muscular metraterm. Genital atrium wide; genital pore ventral, to left of midline, immediately posterior to intestinal bifurcation. Vitellaria of numerous follicles extending in a wide, more or less circular zone from oral sucker to near posterior end of body; confluent or not at level of intestinal bifurcation. Eggs 53-62 by 30-45 μ. Excretory vesicle somewhat sigmoid, slightly overreaching ventral sucker; excretory pore mid-dorsal, between anal openings.

The discoid body shape and dorsal anal openings well removed from the posterior end of the body distinguish this species from all others in the genus *Diploproctodaeum*. Except for anal openings, it is very similar to species of *Pseudocreadium* with which it could easily be confused. Because both genera have all the characteristics of the Lepocreadiidae, there is no justification for maintaining the Diploproctodaeidae Ozaki, 1928, or Dermadenidae Yamaguti, 1958, as families distinct from the Lepocreadiidae.

Although Yamaguti (1958) gives in his key a number of features to distinguish the genera *Pseudocreadium* Layman, 1930, and *Hypocreadium* Ozaki, 1936, descriptions of their species show that differences, even at the generic level, are relative rather than absolute. Thus Yamaguti has referred *P. scaphosomum* Manter, 1940, to *Hypocreadium* but retained *P. lamelliforme* (Linton, 1907) in the genus *Pseudocreadium* when the only difference between the 2 species seems to be the shape of the external seminal vesicle. Bravo-Hollis and Manter (1957) accepted the 2 genera "on the basis of an intertesticular ovary and the uterus extending posterior to the ovary." In the new species described below, the ovary is between the testes but the uterus does not extend posterior to it. Because Sogandares-Bernal (1959) observed variations in the position of the ovary and posterior extent of the uterus in his specimens of *P. scaphosomum*, he considered *Hypocreadium* a synonym of *Pseudocreadium*. We agree with that opinion.

Pseudocreadium **lactophrysi** n.sp.

Figures 25 and 26

Synonym: Pseudocreadium sp. Siddiqi & Cable, 1960.

Hosts: Lactophrys tricornis (C); *L. trigonus* (C); *L. triqueter* (C, J).

Site: intestine.

Holotype: U.S.N.M. 60273.

Description based on 25 mature specimens. Body broadly pyriform to almost circular, 0.333-0.667 long, 0.280-0.710 wide. Entire cuticle spinose; spines partially lost in some specimens; eye-spot pigment present. Oral sucker subterminal, 0.033-0.078 long, 0.053-0.083 wide; ventral sucker subequatorial, 0.056-0.102 in diameter; sucker ratio 1:1.0-1.3. Prepharynx absent; pharynx 0.033-0.068 in diameter; esophagus about same length as pharynx; ceca arching to enclose reproductive system, ending about midway between testes and posterior end of body. Testes symmetrical, irregular, 0.083-0.165 in diameter; cirrus sac to right, not extending posterior to midlevel of ventral sucker, containing large internal seminal vesicle, bipartite pars prostatica and relatively long cirrus. External seminal vesicle an elongated sac

overlapping cirrus sac posterodorsally. Ovary irregular to trilobed, 0.045-0.090 long, 0.060-0.120 wide, immediately posterior to ventral sucker, median or rarely submedian; seminal receptacle large, ovoid, to left of ventral sucker; uterus short, not extending posterior to ovary; metraterm about half length of cirrus sac. Vitelline follicles numerous, extending from level of oral sucker to posterior end of body, confluent dorsally at intestinal bifurcation and posterior to ovary. Eggs few, 58-68 by 33-45 μ. Genital pore to left of midline, at level of, or immediately posterior to intestinal bifurcation. Excretory vesicle tubular, extending to posterior edge of ovary; excretory pore dorsal, far removed from posterior end of body. Siddiqi and Cable (1960) reported the flame cell formula for their immature specimen to be 2[(2+2+2) + (2+2)].

Manter (1945) pointed out that Linton (1907) confused 2 species as *Distomum lamelliforme.* Linton's Figure 75 probably is *P. lactophrysi;* thus 3 rather than 2 species may have been misinterpreted as a single one by Linton.

The broadly pyriform body in combination with a uterus that does not extend posterior to the ovary distinguish *Pseudocreadium lactophrysi* from all species of *Pseudocreadium* except *P. spinosum* Manter, 1940. A comparison of the present material with Manter's description and 3 specimens of *P. spinosum* reveals the following: *P. lactophrysi* is a smaller species but its measurements overlap those of *P. spinosum;* the anterior end is somewhat pointed rather than truncated; a prepharynx is absent; the testes are more anterior and the seminal receptacle is ovoid rather than tubular.

Pseudocreadium anandrum Manter, 1947
Hosts: **Calamus arctifrons* (J); **C. bajanado* (J).
Site: intestine.

Pseudocreadium lamelliforme (Linton, 1907) Manter, 1946
Synonym: Distomum lamelliforme Linton, 1907.
Host: Balistes vetula (J).
Site: intestine.

Pseudocreadium galapagoensis Manter, 1946
Synonym: Pseudocreadium scaphosomum Manter, 1940 in part.
Host: **Balistes ringens* (C).
Site: intestine.

Sogandares-Bernal (1959) described *Pseudocreadium biminensis* from 2 specimens and indicated a close resemblance to *P. galapagoensis.* For his species, he gave 5 distinguishing features which, except for the anterior extent of the vitellaria, are variable in our 17 specimens from Curaçao. Sucker ratios are intermediate, being 1:0.70-1.00 compared with 1:0.51-0.89 for *P. biminensis* and 1:1-1.13 for *P. galapagoensis;* the external seminal vesicle is usually median and transverse but lateral and diagonal in a few of our specimens. In the posterior extent of the cirrus sac, the Curaçao material is like *P. galapagoensis,* but in the position of the ventral sucker, it is like *P. biminensis.* In all 17 specimens, however, the vitellaria extend to the mid- or anterior level of the oral sucker and thus provide the only distinguishing feature between the 2 species. Dr. Manter examined one of our specimens and verified its identification. Minute spines which were observed on the cirrus in living material were not reported by Manter but were seen in a paratype provided by him. The excretory vesicle is pyriform, with its narrower anterior portion receiving 2 canals which extend slightly anterior to the ventral sucker and divide into anterior and posterior secondary tubules, each joined by 2 large groups of flame cells.

Dermadena lactophrysi Manter, 1946
Synonym: Distomum lamelliforme Linton, 1907 in part.
Hosts: Lactophrys tricornis (C); *L. trigonus* (C); *L. triqueter* (C).
Site: intestine.

Superfamily *Opecoeloidea* Cable, 1956
FAMILY OPECOELIDAE Ozaki 1925
Hamacreadium oscitans Linton, 1910
Synonyms: Podocotyle breviformis Manter, 1940; ***Pseudoplagioporus brevivitellus* Siddiqi & Cable, 1960.
Hosts: Anisotremus virginicus (J); **Archosargus unimaculatus* (J); **Bathystoma aurolineatum* (J); **Calamus calamus* (J); **Haemulon album* (C); **H. bonariense* (J); **H. melanurum* (C); *H. sciurus* (J).
Site: intestine.

Our specimens from the various hosts show that the anterior extent of the excretory vesicle depends on the degree of maturity of the trematodes; it reaches the posterior margin of the acetabulum in the immature specimens and only to the ovarian level in mature ones. Reexamination of a paratype of *Pseudoplagioporus brevivitellus* indicates that species to be a synonym of *H. oscitans.*

Hamacreadium mutabile Linton, 1910
Hosts: Lutianus apodus (J); *L. griseus* (J); *L. jocu* (J).
Site: intestine.

Hamacreadium consuetum Linton, 1910
Host: Haemulon sciurus (J).
Site: intestine.

Helicometrina nimia Linton, 1910
Hosts: Haemulon sciurus (J); **Hypoplectrus indigo* (J); **Lachnolaimus maximus* (J); **Lutianus jocu* (J); **Platophrys lunatus* (J); **Spheroides spengleri* (J).
Site: intestine.

Helicometrina trachinoti Siddiqi & Cable, 1960
Host: **Trachinotus glaucus* (J).
Site: intestine.

Six specimens from one fish agree with the original description of the species except that in all of them, the cirrus sax extends to the posterior margin of the ventral sucker.

Helicometra equilata (Manter, 1933) Siddiqi & Cable, 1960
Synonym: Stenopera equilata Manter, 1933.
Host: Holocentrus ascensionis (J).
Site: intestine.

Helicometra execta Linton, 1910
Host: **Halichoeres pictus* (J).
Site: intestine.

Horatrema crassum Manter, 1947
Synonym: Manteriella crassa (Manter) Yamaguti, 1958.
Hosts: Eques acuminatus (J); **E. punctatus* (C).
Site: intestine.

Pinguitrema lobatum Siddiqi & Cable, 1960
Host: Gerres cinereus (J).
Site: intestine.

Pseudopecoeloides carangi (Yamaguti, 1938) Yamaguti, 1940
Synonym: Cymbephallus carangi Yamaguti, 1938.
Hosts: **Caranx crysos* (C); *C. ruber* (C, J).
Site: intestine.

Pseudopecoeloides equesi Manter, 1947
Hosts: Eques acuminatus (C); **E. punctatus* (C).
Site: intestine.

Pseudopecoeloides gracilis Manter, 1947
Host: Selar crumenophthalmus (J).
Site: intestine.

Neopecoelus scorpaenae Manter, 1947
Host: Scorpaena plumieri (C).
Site: intestine.

Our material is identified as this species even though the anal openings could not be confirmed by careful examination of living specimens or whole mounts. In some stained specimens, strands were seen extending posteriorly from the end of each cecum. In other respects, there is close agreement with the original description of the species except that interruption of the vitellaria at the level of each testis occurred in a minority of our specimens.

Opecoeloides brachyteleus Manter, 1947
Hosts: Upeneus maculatus (C, J); *U. martinicus* (C, J).
Site: intestine.

Opecoeloides elongatus Manter, 1947
Hosts: Upeneus maculatus (C, J); *U. martinicus* (C, J).

Opecoeloides vitellosus (Linton, 1900) Von Wicklen, 1946
Synonyms: Distomum vitellosum Linton, 1900; *Anisoporus manteri* Hunninen & Cable, 1940; *Opecoeloides manteri* (Hunninen & Cable) Hunninen & Cable, 1941; **Cymbephallus vitellosus* (Linton) Linton, 1934.
Host: **Epinephelus adscensionis* (J).
Site: intestine.

Von Wicklen (1946) pointed out that Linton had identified as *Distomum vitellosum* more than one species and that *Opecoeloides vitellosus* should be restricted to trematodes that agree with the descriptions given originally by Linton (1900) and later by Hunninen and Cable (1941).

Pseudopecoelus barkeri Hanson, 1950
Hosts: Holocentrus ascensionis (C, J); **H. vexillarius* (C).
Site: intestine.

According to the key to the genus *Pseudopecoelus* given by Manter (1954), our specimens could be either *P. barkeri* Hanson, 1950, or *P. tortugae* (Manter, 1934). In general body shape and indented testes, they are more like *P. tortugae* but egg measurements (45-52 by 27-32 μ) are more like those of *P. barkeri*. The sucker ratio is intermediate (1:1.7-2.3). Thus the 2 species seemingly differ only in egg size.

Pseudopecoelus **holocentri** n.sp.
Figure 27

Synonym: ***Pseudopecoelus elongatus* of Hanson, 1950, nec (Yamaguti, 1938)
Host: Holocentrus ascensionis (C).
Site: intestine.
Holotype: U.S.N.M. 60274.

Description based on 2 specimens. Body slender, 2.45-3.28 long, 0.600-0.667 wide. Oral sucker 0.120-0.130 long, 0.128-0.135 wide; ventral sucker in anterior fourth of body, 0.240-0.280 in diameter, without papillae; sucker ratio 1:2-2.15. Prepharynx short; pharynx 0.105 long, 0.090-0.114 wide; esophagus 0.098-0.112 long; ceca end blindly near posterior end of body. Testes 2, tandem, lobed, not contiguous, 0.293-0.346 long, 0.213-0.273 wide; seminal vesicle tubular, extending about 1/3 distance from ventral sucker to ovary; ejaculatory duct short; pars prostatica indistinct. Ovary pretesticular, slightly irregular, 0.133-0.166 in diameter; uterine seminal receptacle, Mehlis' gland and uterus preovarian; metraterm well-developed. Genital pore sinistral, near anterior margin of pharynx. Eggs 52-54 by 27-30 μ. Vitelline follicles extending from near posterior level of ventral sucker to the posterior end of body, interrupted opposite gonads. Excretory vesicle extending to ovarian level; pore terminal.

The only other species of *Pseudopecoelus* with vitellaria interrupted opposite the gonads is *P. elongatus* (Yamaguti, 1938). That species differs from *P. holocentri* in having a smaller pharynx, a different sucker ratio (1:1.56 compared with 1:2-2.15) and a longer posttesticular space.

Some of the specimens which Hanson (1950) reported as *P. elongatus* have been examined and found to agree with the present species except in having somewhat less irregular gonads.

Pseudopecoelus **gymnothoracis** n.sp.
Figure 28

Host: Gymnothorax moringa (C).
Site: intestine.
Holotype: U.S.N.M. 60275.

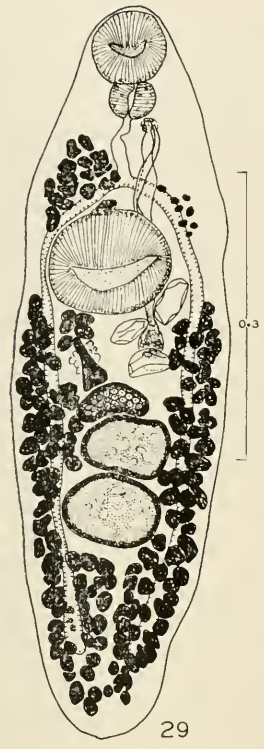
Description based on 8 specimens. Body pyriform to linguiform, 1.40-1.85 long, 0.637-0.830 wide. Cuticle smooth. Oral sucker 0.113-0.133 long, 0.120-0.153 wide. Ventral sucker 0.200-0.233 long, 0.233-0.273 wide; sucker ratio 1:1.7-2.1. Prepharynx short; pharynx 0.038-0.060 in diameter; esophagus 3-5 times length of pharynx; intestinal bifurcation about midway between suckers; ceca converge posteriorly, ending blindly at about midlevel of posttesticular space. Testes 2, extremely lobed, constricted medially, 0.113-0.266 long, 0.333-0.440 wide. Cirrus sac absent; seminal vesicle tubular, extending well posterior to acetabulum but not reaching ovary; pars prostatica weakly developed, prostate cells few; ejaculatory duct short. Ovary lobed, pretesticular, submedian, 0.100-0.120 long, 0.173-0.200 wide; uterine seminal receptacle, Mehlis' gland and uterus preovarian; Laurer's canal present; metraterm well-developed. Genital atrium small, genital pore sinistral, at about midesophageal level. Eggs 54-69 by 30-45 μ, usually 63-67 by 37-42. Vitelline follicles numerous, extending along entire length of ceca, confluent at intestinal bifurcation. Excretory vesicle tubular, extending to ovarian level.

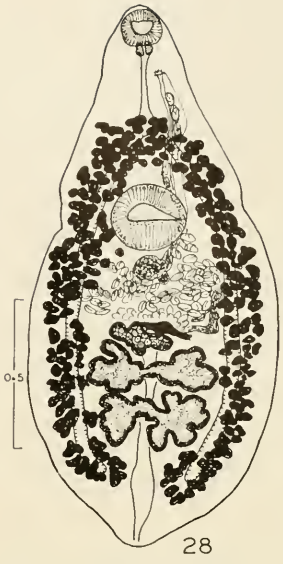
The combination of highly lobed and medially constricted testes with vitelline follicles broadly confluent at the intestinal bifurcation distinguishes this species from all others in the genus *Pseudopecoelus*.

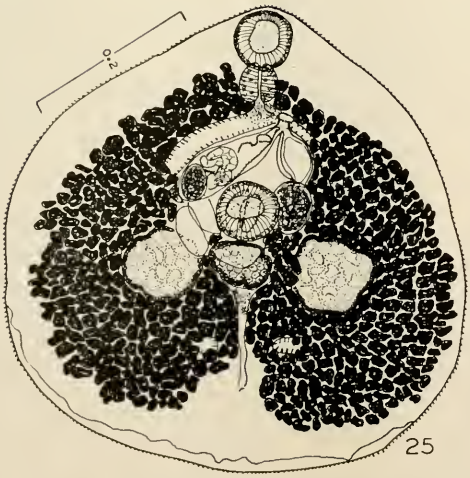
Pseudopecoelus **minutus** n.sp.
Figure 29

Host: Doratonotus megalepis (C).
Site: intestine.
Holotype: U.S.N.M. 60276.

Description based on 6 specimens, measurements on 4 mature ones. Body elongated, rounded at both ends, 0.606-0.720 long, 0.180-0.233 wide. Oral sucker 0.063-0.075 in diameter; ventral sucker at junction of anterior and middle third of body, 0.105-0.135 in diameter; sucker ratio 1:1.7-2.0.







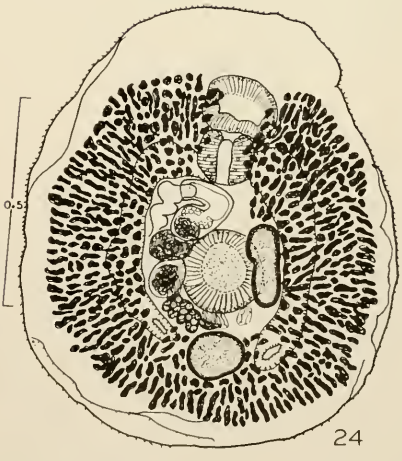


Figure 24. *Diploproctodaeum diodontis*, holotype, dorsal view. **Figure 25.** *Pseudocreadium lactophrysi*, holotype, ventral view. **Figure 26.** Same, cirrus sac of another specimen drawn free-hand. **Figure 27.** *Pseudopecoelus holocentri*, holotype, dorsal view. **Figure 28.** *Pseudopecoelus gymnothoracis*, holotype, ventral view. **Figure 29.** *Pseudopecoelus minutus*, holotype, ventral view.

Prepharynx absent; pharynx 0.030-0.040 long, 0.042-0.048 wide; esophagus 1-2 times length of pharynx; ceca end blindly a short distance from posterior end of body. Testes 2, tandem, entire, contiguous, 0.045-0.120 in diameter; seminal vesicle long, reaching about midway between ventral sucker and ovary; pars prostatica not evident. Ovary pretesticular, subtriangular, smooth, 0.030-0.075 in diameter; Mehlis' gland, uterine seminal receptacle and uterus preovarian; metraterm well-developed. Genital atrium muscular; genital pore sinistral, near posterior margin of pharynx. Eggs few, 45-54 by 22-30 μ. Vitelline follicles extending anterior to ventral sucker, usually interrupted lateral to acetabulum. Excretory vesicle tubular, extending to level of ovary; excretory formula $2[(2+2) + (2+2)] = 16$ flame cells.

Only *Pseudopecoelus gibbonsiae* Manter and Van Cleave, 1951, shares with this species the combined features of an entire ovary and vitellaria that extend anterior to the acetabulum. However, *P. gibbonsiae* is much larger (2.26-2.55 by 0.643-0.780) and its eggs almost twice the size of those of *P. minutus*.

The pygmy wrasse which harbors this species lives in clumps of rockweed in close association with the snail, *Columbella mercatoria,* and an amphipod which probably serve as intermediate hosts. A minute opecoelid cercaria, to be described elsewhere, develops in that snail and was observed to penetrate and encyst in the amphipod.

Coitocaecum sp.

Figure 30

Host: Labrisomus bucciferus (J).
Site: intestine.
Deposited specimen: U.S.N.M. 60277.

Description based on a single specimen. Body elongated, rounded at both ends, 0.750 by 0.267. Cuticle smooth. Oral sucker 0.067 by 0.084; ventral sucker subequatorial, 0.126 by 0.150, with transverse aperture; sucker ratio 1:1.84. Prepharynx short; pharynx 0.045 by 0.065; esophagus 0.115 long; intestinal bifurcation about midway between pharynx and acetabulum; cyclocoel gut extending to near posterior end of body. Testes tandem, contiguous, 0.045-0.050 long, 0.065-0.072 wide; seminal vesicle pyriform, preacetabular; followed by a narrow duct leading to inconspicuous cirrus sac anterior to arch of left cecum; content of cirrus sac not evident; genital pore sinistral, at esophageal level. Ovary pretesticular, slightly dextral, 0.045 by 0.065. Mehlis' gland preovarian; seminal receptacle absent; uterus not extending to posterior testis; metraterm simple. Eggs collapsed, 48-56 by 27-33 μ. Vitellaria extending from esophageal level to posterior end of body, confluent in posttesticular space but not at intestinal bifurcation.

This species is described and figured but not named because only one specimen in poor condition was found.

FAMILY OPISTHOLEBETIDAE
Fukui, 1929

Opistholebes diodontis Cable, 1956
Host: Diodon hystrix (C, J).
Site: intestine.

Pachycreadium crassigulum (Linton, 1910) Manter, 1954
Synonyms: Lebouria crassigula Linton, 1910; *Plagioporus crassigulus* (Linton) Price, 1934.
*Hosts: *Calamus arctifrons* (J); *C. bajanado* (J); **Archosargus unimaculatus* (J).
Site: intestine.

Superfamily Allocreadioidea Nicoll, 1934
FAMILY GORGODERIDAE Looss, 1901

Xystretrum solidum Linton, 1910
Synonyms: Catoptroides aluterae MacCallum, 1917; *Catoptroides magnum* MacCallum, 1917; *Macia pulchra* Travassos, 1921; *Xystretrum pulchrum* (Travassos) Manter, 1947; *Xystretrum papillosum* Linton, 1910.
*Hosts: *Balistes vetula* (J); **Cantherines pullus* (J); **Canthigaster rostratus* (C); **Lactophrys tricornis* (J); *Spheroides testudineus* (J).
Site: urinary bladder and kidney ducts.

The effect of crowding on the size of this species, mentioned by Manter (1947), was shown by the more than 100 specimens with which the kidney ducts and bladder of one *Canthigaster rostratus* were literally stuffed.

Phyllodistomum **pomacanthi** n.sp.

Figure 31

Host: Pomacanthus arcuatus (J).
Site: posterior intestine.
Holotype: U.S.N.M. 60278.

Description based on a single specimen. Body foliate, sides inrolled ventrally, 3.28

long, 1.49 in maximum width, at level of posterior testis. Oral sucker 0.334 by 0.374; ventral sucker slightly preequatorial, 0.267 by 0.240; sucker ratio 1:0.71. Pharynx absent; esophagus 0.188 long; ceca wide, extending almost to excretory pore. Testes 2, diagonal, intercecal, lobed, separated by coils of the uterus; anterior testis 0.266 by 0.333, to left of midline; posterior testis 0.280 by 0.306, 0.70 from posterior end of body; seminal vesicle anterior to genital pore, globular, wall poorly defined; prostate cells free in parenchyma; ejaculatory duct short, curves from seminal vesicle posteriorly to enter thick-walled genital atrium; genital pore about midway between intestinal bifurcation and acetabulum. Ovary pretesticular, indented or irregular, to right of midline, 0.240 by 0.200; seminal receptacle absent; Mehlis' gland between vitellaria; uterus extending to near ends of ceca; metraterm well-developed. Eggs few, 24-36 by 14-23 μ. Vitellaria 2 lobed masses, close together but separated by uterus, symmetrically placed, a short distance posterior to ventral sucker. Excretory vesicle not evident; pore dorsal, some distance from posterior end of body.

Phyllodistomum pomacanthi is most like *P. carangis* Manter, 1947, but differs from that species chiefly in being much smaller, and in having lobed testes, a more posterior ventral sucker and ceca extending farther posteriorly.

FAMILY ZOOGONIDAE Odhner, 1911

The present study includes species belonging to the genera *Diplangus, Deretrema, Steganoderma* and *Diphtherostomum.* Skrjabin (1957) has placed all but *Diphtherostomum* in the family Steganodermatidae Dollfus, 1952, in which the vitellaria are more extensive and the eggs thicker-shelled than in the Zoogonidae. He also erected the superfamily Zoogonoidea to include those families. Yamaguti (1958) assigned *Diplangus* to the family Callodistomidae Poche, 1926, but left the others in the Zoogonidae. Until those arrangements can be evaluated on the basis of life history studies, we prefer to leave all 4 genera in the Zoogonidae and, tentatively, in the superfamily Allocreadioidea.

Diplangus paxillus Linton, 1910

Hosts: Anisotremus virginicus (J); *Haemulon sciurus* (J); **Gerres cinereus* (J).

Site: intestine.

Diplangus parvus Manter, 1947

Host: **Haemulon sciurus* (J).

Site: intestine.

Deretrema fusillum Linton, 1910

Host: **Mycteroperca bonaci* (C).

Site: intestine.

Steganoderma nitens (Linton, 1898) Manter, 1947

Synonyms: Distomum nitens Linton, 1898; *Lecithostaphylus nitens* (Linton) Linton, 1940; ***Steganoderma elongatum* Manter, 1947.

Host: **Strongylura ardeola* (C).

Site: intestine.

Variations in our 3 specimens overlap features used by Manter (1947) to separate *Steganoderma elongatum* from *S. nitens.* Reexamination of type specimens shows that the genital pore in *S. nitens* is more lateral than Linton (1898) figured and that its relatively far anterior position in *S. elongatum* is due to contraction of the forebody.

A striking feature of this species, not mentioned by either Linton or Manter, is the presence of conspicuous glands occupying the full width of the body from near the vitellaria to a short distance anterior to the acetabulum. They were seen in Manter's type specimen but could not be recognized with certainty in Linton's because of its condition. On each side, anterior to those glands, is a group of several less conspicuous ones with ducts extending anteriorly in a distinct bundle to separate and open at clusters of pores on the anterior margin of the oral sucker.

Steganoderma hemiramphi Manter, 1947

Figure 32

Hosts: Hemiramphus brasiliensis (C, J); *Gerres cinereus* (J).

Site: intestine.

That the larva of this species is an ophthalmoxiphidiocercaria is evident from the presence of eye-spot pigment in the forebody and a stylet (Fig. 32) in the oral sucker of one of 2 specimens from Curaçao. In known zoogonid life histories, the larva has a stylet but no tail or eye-spots. In the Monorchiidae, cercariae with eye-spots have a well developed tail whereas the absence of eye-spots is usually accompanied by more or less reduction of the tail. Should that situation

apply to the Zoogonidae, the life history of *Steganoderma hemiramphi* could be decisive in determining the affinity of its family to others, a matter that is still obscure.

Steganoderma atherinae (Price, 1934) Manter, 1947

Synonym: Lecithostaphylus atherinae Price, 1934.

Hosts: Hepsetia stipes (J); **Strongylura timucu* (C).

Site: intestine.

The single specimen from Curaçao, although from a new host, is in close agreement with the species as described elsewhere in the Caribbean region. However, none of many individuals of *Hepsetia stipes* examined in Curaçao harbored this species whereas it was found in almost all *H. stipes* in Jamaica.

Diphtherostomum **anisotremi** n.sp.

Figure 33

Host: Anisotremus virginicus (J).

Site: intestine.

Holotype: U.S.N.M. 60279.

Description based on 8 specimens. Body plump, tapering toward both ends, 0.440-0.767 long, 0.173-0.267 wide. Cuticle of forebody with large spines; hindbody smooth. Oral sucker 0.060-0.090 in diameter; ventral sucker equatorial to slightly postequatorial, somewhat quadrangular, 0.120-0.210 in diameter; sucker ratio 1:2-2.35. Prepharynx absent; pharynx 0.026-0.037 in diameter; esophagus 3-4 times length of pharynx; ceca not quite reaching midlevel of acetabulum. Testes 2, symmetrical to diagonal, immediately posterior to or overlapping posterior margin of ventral sucker; cirrus sac arcuate, elongated, 0.195-0.233 long, 0.039-0.060 wide, extending to and sometimes overlapping anterior margin of acetabulum; containing bipartite seminal vesicle, ovoid pars prostatica, prostate cells and spiny cirrus. Genital pore sinistral, just posterior to level of intestinal bifurcation. Ovary smooth, dorsal to acetabulum, 0.064-0.105 long, 0.050-0.083 wide; seminal receptacle postovarian; uterus occupying most of hindbody; metraterm muscular, spiny, about same length as cirrus sac. Eggs very thin-shelled, 27-36 by 9-14 μ. Vitellaria in 2 masses, 0.030-0.078 in diameter, near posterior margin of acetabulum. Excretory vesicle short, sac-shaped; pore terminal.

This species hesitantly is reported as new because of its similarity to *Diphtherostomum americanum*. However, Manter (1947) described that species as having a very short esophagus and a cirrus sac with a width of 1/2-3/4 its length whereas in *D. anisotremi*, the esophagus is at least 3 times as long as the pharynx and the cirrus sac is about 4 times as long as wide. The figure of a trematode identified by Sogandares-Bernal and Hutton (1959b) as *D. americanum* shows an elongated cirrus sac but a short esophagus.

FAMILY MONORCHIIDAE Odhner, 1911

The status of *Genolopa* Linton, 1910, *Proctotrema* Odhner, 1911, *Lasiotocus* Looss, 1907, and other related genera has been reviewed by many authors including Yamaguti (1934), Hopkins (1941), Manter (1942), Nagaty (1948) and more recently by Thomas (1959) and Manter and Pritchard (1961). We accept the genus *Genolopa* for species with atrial spines as suggested by Manter and Pritchard. These authors also suggested that *Lasiotocus* be separated from *Proctotrema* on the basis of an entire ovary versus a 3- or 4-lobed one. In some trematodes this character is variable. In the hemiurid, *Dichadena acuta*, for instance, the ovary may be entire or distinctly 4-lobed. Moreover, lobation may be a matter of degree which can vary with handling of specimens or with their age. However, our material can be allocated between *Lasiotocus* and *Proctotrema* as distinguished by Manter and Pritchard and, for that reason, the validity of both genera is accepted at this time. Actually *Lasiotocus* was never published by Looss as a formal name; instead it was mentioned in a subjunctive sense in criticizing the Rules of Nomenclature. However facetious the intent of Looss may have been, the Law of Priority establishes the validity of such names. Thus *Lasiotocus* would take priority over *Proctotrema* if those genera are considered to be synonymous.

Genolopa ampullacea Linton, 1910

*Synonym: **Genolopa longicaudata* Siddiqi & Cable, 1960.

Hosts: Bathystoma striatum (J); *Haemulon album* (J); **H. bonariense* (J); *H. flavolineatum* (C, J); **H. melanurum* (C); *H. sciurus* (J).

Site: ceca and intestine.

Siddiqi and Cable (1960) described *Genolopa longicaudata* from *Odontoscion dentex* and, in a key, distinguished it from *G. ampullacea* on the basis of having a posttesticular space "3 or 4 times length of testis" and a metraterm sac "reaching well posterior to ventral sucker." Our more abundant material shows that these features are highly variable; *G. longicaudata* accordingly is reduced to synonymy with *G. ampullacea.*

Genolopa brevicaecum (Manter, 1942) Manter and Pritchard, 1961

Synonym: Paraproctotrema brevicaecum Manter, 1942.

Host: Caranx bartholomaei (J).

Site: intestine.

Seventeen specimens from 2 fish are in close agreement with Manter's description and measurements. The majority of the worms are elongate, spindle-shaped but a few are pyriform. They also confirm the presence of the atrial spines reported by Manter and Pritchard (1961). In most specimens, the spines were difficult to distinguish from those on the cirrus but 2 worms with that organ retracted, show a ring of spines around the genital atrium. The metraterm is unspined.

Lasiotocus longicaecum (Manter, 1940) Yamaguti, 1953

Synonym: Proctotrema longicaecum Manter, 1940.

Host: Anisotremus virginicus (J).

Site: ceca and intestine.

Lasiotocus truncatus (Linton, 1910) Thomas, 1959

Synonyms: Genolopa truncatum Linton, 1910; *Proctotrema truncatum* (Linton) Manter, 1940.

*Hosts: *Bathystoma aurolineatum* (J); **Brachygenys chrysargyreus* (C); **Calamus calamus* (J); *Haemulon album* (C); **H. bonariense* (J); *H. flavolineatum* (C, J); *H. sciurus* (J); **Lutianus mahogoni* (C).

Site: ceca and intestine.

Lasiotocus longovatus (Hopkins, 1941) Thomas, 1959

Synonyms: Genolopa longovatum Hopkins, 1941; *Proctotrema longovatum* (Hopkins) Manter, 1942.

*Hosts: *Bathystoma aurolineatum* (J); **Haemulon bonariense* (J); **H. flavolineatum* (C); **H. sciurus* (J).

Site: ceca and intestine.

Seventy trematodes are referred to this species on the basis of egg size and other measurements, length of ceca and general topography of organs. We did not observe the urn-shape described by Hopkins (1941) in either living or mounted specimens. However, Hopkins states (p. 401) "This is almost certainly the same species as the specimen shown in Figure 223 of Linton (1910) under the name *'Monostomum* sp.'." Obviously, he was referring to Linton (1905) since Figure 223 of Linton's 1910 paper represents a bucephalid. Our material is very similar to Linton's in the shape of the body and oral sucker.

Proctotrema **pritchardae** n.sp.

Figure 34

Host: Haemulon album (C).

Site: intestine.

Holotype: U.S.N.M. 60280.

Description based on 2 specimens. Body elongated, rounded at both ends, 1.158 to 1.22 long, 0.40 wide. Cuticular spines extend along entire length of body; eye-spot pigment absent. Oral sucker somewhat funnel-shaped to spherical, 0.142-0.160 long, 0.172-0.180 wide; ventral sucker in middle third of body, 0.105-0.113 long, 0.090-0.098 wide; sucker ratio 1:0.60-0.64. Prepharynx short; pharynx 0.072-0.075 long, 0.075-0 083 wide; esophagus about same length as pharynx; intestinal bifurcation about midway between pharynx and ventral sucker; ceca long, extending to near posterior end of body. Gonads in middle third of body. Testis median, entire, 0.150-0.246 in diameter; cirrus sac 0.233-0.255 long, 0.105 wide, to right of midline, extending to posterior margin of ovary; containing spherical seminal vesicle, tubular pars prostatica and cirrus with small, inconspicuous spines. Ovary with 3 or 4 distinct lobes, to right of midline, immediately anterior to, or overlapped by testis. Metraterm sac 0.210-0.213 long, 0.105-0.109 wide, consisting of large posterior vesicle without spines and smaller spinose anterior portion, separated by sphincter; metraterm spines distinct, about 12 μ long, larger than those of cirrus. Uterus voluminous, mostly posttesticular; distal end entering spiny portion of metra-

term sac just anterior to sphincter. Genital atrium unarmed, genital pore median, about midway between ventral sucker and intestinal bifurcation. Eggs numerous, 18-21 by 10-12 μ. Vitellaria in lateral groups of 9-10 follicles each extending from anterior margin of ovary to midlevel of testis. Excretory vesicle tubular, anterior extent not determined; pore terminal.

Manter and Pritchard (1961) recognize the following species of *Proctotrema: P. bacilliovatum* Odhner, 1911, *P. macrorchis,* Yamaguti, 1934, *P. plectorhynchi* Yamaguti, 1934, *P. chaetodipteri* (Thomas, 1959), *P. himezi* (Yamaguti, 1951), *P. parvum* Manter, 1942, and *P. latum* (Manter, 1942). *Proctotrema pritchardae* differs from *P. bacilliovatum, P. plectorhynchi,* and *P. macrorchis* chiefly in having smaller eggs, longer ceca, and in the shape of the oral sucker; from *P. chaetodipteri* in body shape and length of posttesticular space; from *P. himezi* in having longer ceca; from *P. parvum* in having smaller eggs and much longer ceca, and from *P. latum* in body shape and accompanying topography of internal structures.

The species is named in honor of Mrs. Mary Hanson Pritchard in recognition of her work in the field of trematodology.

Proctotrema **anisotremi** n.sp.

Figure 35

Host: Anisotremus virginicus (J).
Site: ceca and intestine.
Holotype: U.S.N.M. 60281.

Description based on 10 specimens. Body oval, 0.500-0.714 long, 0.267-0.400 in maximum width, at level of vitellaria. Entire cuticle spinose, eye-spot pigment absent. Oral sucker 0.090-0.113 long, 0.105-0.135 wide; ventral sucker somewhat preequatorial, 0.055-0.067 long, 0.060-0.075 wide; sucker ratio 1:0.52-0.70. Prepharynx very short; pharynx subspherical, 0.038-0.051 in diameter; esophagus very short; ceca extending just posterior to testis. Gonads in middle third of body. Testis entire, to right of midline, 0.120-0.180 long, 0.099-0.155 wide; cirrus sac crescent-shaped, to right of midline, 0.140-0.195 long, 0.060-0.090 wide, extending to posterior margin of acetabulum or slightly beyond, containing large spherical seminal vesicle, short tubular pars prostatica and cirrus with spines about 8 μ long. Ovary immediately pretesticular, at level of ventral sucker, with 3 almost separate lobes; uterus filling posttesticular space and left side of hindbody, joining metraterm sac immediately posterior to sphincter. Metraterm sac smaller than cirrus sac, 0.113-0.160 long, 0.045-0.075 wide, rarely extending posterior to ventral sucker; consisting of large, posterior vesicle without spines separated from a smaller anterior spinose division by a sphincter; metraterm spines slightly larger than those of cirrus. Genital atrium unarmed, genital pore median, about midway between acetabulum and intestinal bifurcation. Eggs thin-shelled, 17-20 by 9-11 μ. Vitellaria in 2 lateral groups of 8 or 9 follicles each, extending from about midlevel of acetabulum to that of testis. Excretory vesicle not observed; pore terminal.

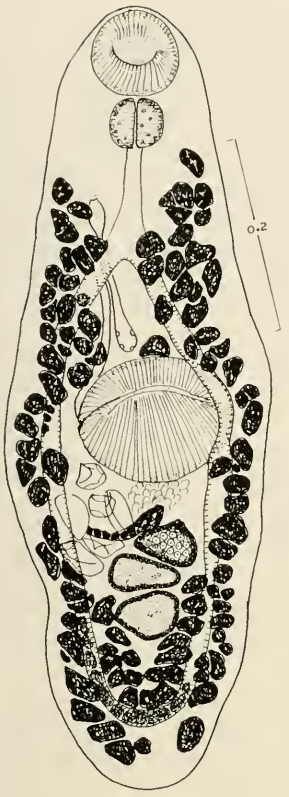
Proctotrema anisotremi is to be compared with *P. parvum* and *P. latum* which have a more or less spherical oral sucker. It differs from *P. parvum* in having smaller eggs, longer ceca and large cirrus sac, and in the position of the testis. Although described from the same host as *P. anisotremi, P. latum* differs in having a characteristically broad shape emphasized by Manter (1942), a proportionally larger cirrus sac extending posterior to ventral sucker, a more anterior genital pore, and longer ceca. Similarities include shape of oral sucker, position of testis, and lobation and position of ovary. *P. anisotremi* differs from *P. pritchardae* in shape of ovary, in position of testis and in having shorter ceca.

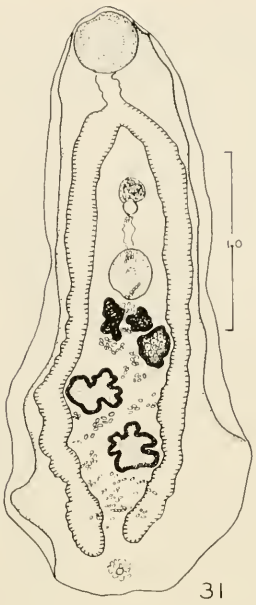
Chrisomom **decapteri** n.sp.

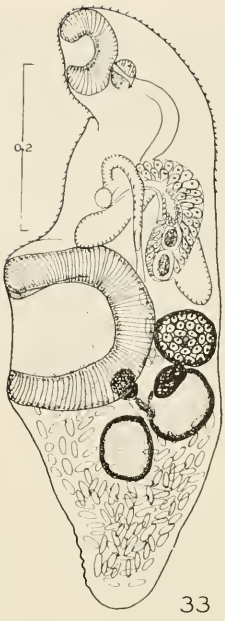
Figures 36 and 37

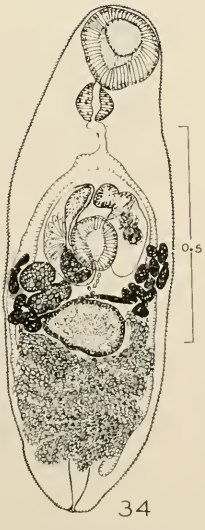
Host: Decapterus macarellus (C).
Site: intestine.
Holotype: U.S.N.M. 60282.

Description based on 6 specimens. Body elongated, rounded at both ends, 0.900-1.50 long, 0.300-0.400 wide (one additional specimen without eggs measured 0.772 by 0.220). Cuticular spines numerous to posterior edge of ventral sucker, then become sparse and shortly disappear. Eye-spot pigment present. Oral sucker transversely elongated, 0.045-0.063 long, 0.060-0.090 wide; ventral sucker about 1/3 body length from anterior end, 0.084-0.090 long, 0.054-0.084 wide; sucker ratio 1:1-1.15. Prepharynx about half length of pharynx; pharynx 0.053-









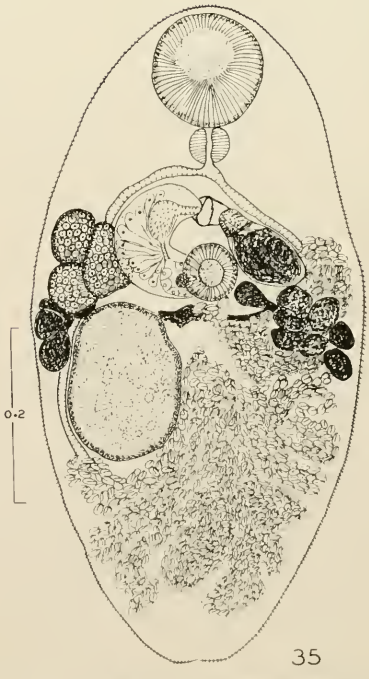


Figure 30. *Coitocaecum* sp., dorsal view. **Figure 31.** *Phyllodistomum pomacanthi*, holotype, dorsal view. **Figure 32.** Stylet of *Steganoderma hemiramphi*, drawn free-hand from living specimen. **Figure 33.** *Diphtherostomum anisotremi*, holotype, ventrolateral view. **Figure 34.** *Proctotrema pritchardae*, holotype, ventral view. **Figure 35.** *Proctotrema anisotremi*, holotype, ventral view. **Figure 36.** *Chrisomon decapteri*, holotype, dorsal view. **Figure 37.** Same, eggs enlarged.

0.083 in diameter; esophagus 2-2.5 times length of pharynx; ceca long, extending to near posterior extremity. Testis elongated, almost half body length; cirrus sac to right of midline, 0.150-0.374 long, 0.050-0.064 wide, containing spherical seminal vesicle, tubular pars prostatica and cirrus with small spines 9-12 μ long. Ovary irregularly lobed, to left of and usually overlapping testis anteriorly. Metraterm sac almost as large as cirrus sac, consisting of posterior vesicle with a few scattered spines and anterior division with numerous spines similar to those of cirrus. Uterus extending posterior to testis, overlapping it ventrally and entering metraterm sac near its anterior spiny portion. Genital atrium small, without spines; its pore median, preacetabular. Vitellaria in lateral fields, extending from anterior edge of ovary or posterior margin of cirrus sac to tips of ceca; follicles elongated, tending to fuse. Eggs 20-24 by 12-17 μ, rounded at one end, tapering at other (Fig. 37). Excretory vesicle sac-shaped, very short; pore terminal.

This species is so similar to *C. tropicum* (Manter, 1940) that further collections of *C. tropicus* from the Pacific might prove the 2 to be identical. The main differences, which may be due to development in different host species, are the larger and more elongated testis, slightly more extensive vitellaria and a somewhat more anterior ovary in *C. decapteri*. Similarities concern such details as shape of the eggs, the presence of 3 or 4 large spines in the posterior portion of the metraterm sac, extent of spination and measurements. Manter (1940a) described a very short, Y-shaped excretory vesicle in *C. tropicum* whereas it was observed to be short but sac-shaped in living specimens of *C. decapteri;* Manter may have interpreted the expanded main excretory ducts as part of the vesicle. In living *C. decapteri,* the uterus was seen to join the metraterm sac at its anterior, more spinose portion whereas Manter described that junction as being at the posterior end of the sac. We studied the type specimen of *C. tropicus* and concluded that the uterus enters the metraterm sac as in *C. decapteri.* Dr. Manter reexamined the specimen and agreed with that interpretation. Thus the diagnosis of the genus must be emended as follows:

Genus *Chrisomom* emended

Monorchiidae: Body elongated; esophagus more than twice length of pharynx; testis single, elongated, near posterior end of body; cirrus sac and metraterm sac spinose; ovary irregularly lobed; uterus extending posterior to testis or not, joining more spinose anterior portion of metraterm sac; vitelline follicles numerous, extending most of length of hindbody but not reaching acetabulum; excretory vesicle sac-shaped, short; parasites in intestine of marine fishes. Type species: *C. tropicus* (Manter, 1940) Manter & Pritchard, 1961 (Synonym: *Telolecithus tropicus* Manter); other species: *C. decapteri* n.sp.

A single specimen from *Selar crumenophthalmus* from Jamaica is in agreement with the measurements and general topography of both species of *Chrisomon* except that the testis, due to distortion and poor fixation, is more anterior, and the cirrus sac overlaps the metraterm covering it more or less completely. Its identification, therefore, remains undetermined.

Postmonorchis orthopristis Hopkins, 1941

Synonym: Pristisomum orthopristis (Hopkins) Yamaguti, 1958.

*Hosts: *Gerres cinereus* (J); **Haemulon album* (J); **H. flavolineatum* (C, J); **H. sciurus* (J).

Site: intestine.

Pseudohurleytrema eucinostomi (Manter, 1942) Yamaguti, 1954

Synonym: Hurleytrema eucinostomi Manter, 1942.

*Hosts: *Eucinostomus pseudogula* (J); *Gerres cinereus* (C).

Site: intestine.

Our specimens differ from Manter's only in having somewhat smaller eggs (22-26 by 12-16 μ compared with 26-28 by 20). Siddiqi and Cable (1960) reported the same species from Puerto Rico; in their specimens, eggs measured 27-30 by 11-15 μ (unpublished data).

Hurleytrematoides chaetodoni (Manter, 1942) Yamaguti, 1954

Synonym: Hurleytrema chaetodoni Manter, 1942.

Hosts: Chaetodon capistratus (C, J); *C. striatus* (J).

Site: intestine.

Hurleytrematoides **curacaensis** n.sp.

Figures 38 and 39

Hosts: Chaetodon capistratus (C); *Chaetodon ocellatus* (C).

Site: intestine.

Holotype: U.S.N.M. 60283.

Description based on 20 specimens. Body elongated, more rounded posteriorly, 0.880-1.26 long, 0.175-0.267 wide. Entire cuticle densely spinose; eye-spot pigment present. Oral sucker 0.053-0.075 in diameter; ventral sucker in anterior fourth or third of body, 0.045-0.060 in diameter; sucker ratio 1:0.8-0.9. Prepharynx very short; pharynx 0.030-0.039 long, 0.039-0.054 wide; esophagus 2-3 times length of pharynx; intestinal bifurcation well anterior to ventral sucker; ceca long, extending to midlevel of posttesticular space or slightly beyond. Gonads median, in about middle third of hindbody. Testis entire, 0.143-0.246 long, 0.113-0.173 wide. Posttesticular space 0.240-0.426 long. Cirrus sac well-developed, to right of midline, 0.158-0.195 long, 0.040-0.50 wide, containing a bipartite seminal vesicle, a short pars prostatica and a cirrus with needle-like spines, 8-11 μ long. Ovary entire, pretesticular, 0.067-0.100 in diameter; seminal receptacle not evident; uterus mainly posttesticular, coils mostly transverse; metraterm sac absent; metraterm well-developed, 0.083-0.105 long, 0.030-0.033 wide; entire length with spines 7-10 μ long, similar in shape to those of cirrus. Genital atrium without spines; genital pore median, immediately preacetabular. Eggs 27-33 by 16-23 μ, exclusive of single unipolar filament, 1-1.5 times length of egg. Vitellaria with 10-15 follicles on each side, well posterior to acetabulum, mostly pretesticular, a few sometimes extending to midlevel of testis. Excretory vesicle tubular; its pore terminal.

This species is very similar to *H. chaetodoni*. Both are from *Chaetodon capistratus* and one individual harbored both trematodes. *H. curacaensis* differs from *H. chaetodoni* mainly in having a smaller ventral sucker and wider eggs with much shorter filaments. The uterine coils tend to be more transverse than longitudinal and they lack the strand-like appearance characteristic of *H. chaetodoni*. The eggs of *H. chaetodoni* are highly variable in length. Exclusive of the filament, they measure 37-42 by 15-17 μ in our specimens. A single specimen reported from Puerto Rico by Siddiqi and Cable (1960) has eggs measuring 52-54 by 15-16 (unpublished data). Sogandares-Bernal and Sogandares (1961) gave a length of 30-32 and suggested that it may vary with populations. In *H. coronatum* Manter and Pritchard, 1961, the filament is 10-15 times the length of the egg. *H. malaboensis* Velasquez, 1961, has a longer egg filament (7-8 times length of egg), apparently a non-spiny cirrus and longer ceca.

The next species could be assigned to the genus *Hurleytrematoides* if it had one instead of 2 testes. Hence a new genus is erected for it, and diagnosed as follows:

Diplohurleytrema n.g.

Monorchiidae: subfamily Hurleytrematinae: Body spinose, elongated; eye-spot pigment absent. Acetabulum preequatorial; ceca short; esophagus long. Testes 2, diagonal; cirrus sac long, containing bipartite seminal vesicle and spiny cirrus. Ovary entire, pretesticular, in anterior half of body; seminal receptacle present; metraterm sac absent; uterus occupying most of hindbody. Vitelline follicles lateral, mostly in anterior half of body. Genital pore preacetabular. Eggs with single unipolar filaments. Excretory vesicle tubular. Parasitic in intestine of marine fishes. Type and only species:

Diplohurleytrema brevicaecum n.g., n.sp.

Figure 40

Host: Echidna catenata (C).

Site: intestine.

Holotype: U.S.N.M. 60284.

Description based on 25 specimens. Body elongated, rounded anteriorly, tapering posteriorly, 0.566-1.25 long, 0.213-0.407 wide, Entire cuticle spinose, with spines becoming smaller posteriorly; eye-spot pigment absent. Oral sucker 0.107-0.180 long, 0.135-0.200 wide; ventral sucker preequatorial, 0.083-0.146 long, 0.090-0.160 wide; sucker ratio 1:0.70-0.80. Prepharynx absent; pharynx 0.039-0.070 in diameter; esophagus thick-walled, 3-4 times length of pharynx, usually sinuous, surrounded by gland cells; ceca short, terminating in zone of anterior testis. Testes 2, entire, usually diagonal, rarely almost symmetrical or nearly tandem, 0.083-0.200 in diameter; anterior testis to

right of midline, posterior testis slightly to left. Cirrus sac 0.233-0.467 long (1/3-1/2 body length), 0.045-0.080 wide; slightly to left of midline; containing bipartite seminal vesicle, very small and indistinct pars prostatica and long cirrus armed with minute spines, difficult to see in stained specimens but evident in living material. Ovary entire, to left of midline, anterior to testes; seminal receptacle large, posterodorsal to ovary, overlapping tip of left cecum; Mehlis' gland posteromedian to ovary; Laurer's canal opens dorsal to posterior end of cirrus sac; uterus strand-like in appearance, filling a large portion of the posttesticular space and terminating in muscular, thick-walled metraterm with finely stippled lining (spines ?). Genital atrium spacious; its pore median, immediately posterior to intestinal bifurcation. Eggs 30-37 long by 13-17 μ wide, exclusive of single unipolar filament 2-3 times length of egg. Vitellaria in lateral groups of 25-30 follicles each, extending from posterior level of pharynx to midlevel of anterior testis. Excretory vesicle tubular, extending to anterior testis; pore terminal.

Diplomonorchis **myrophitis** n.sp.

Figures 41 and 42

Host: Myrophis punctatus (J).

Site: intestine.

Holotype: U.S.N.M. 60285.

Description based on 3 specimens. Body oval, 0.887-1.062 long, 0.347-0.513 wide. Cuticle with spines close together anteriorly becoming sparse posteriorly. Eye-spot pigment present. Oral sucker 0.097-0.108 long, 0.105-0.113 wide; ventral sucker in middle third of body length, 0.072-0.075 long, 0.054-0.072 wide; sucker ratio 1:0.63-0.70. Prepharynx absent; pharynx 0.045-0.053 in diameter; esophagus about as long as pharynx; ceca extending short distance posterior to testes. Gonads in middle third of body. Testes 2, 0.113-0.140 long, 0.108-0.167 wide, entire, symmetrical, lateral portions extracecal. Cirrus sac to right of acetabulum, 0.200-0.253 long, 0.090-0.100 wide, extending posteriorly to mid- or posterior level of ovary, enclosing seminal vesicle, small inconspicuous pars prostatica, and spiny cirrus. Metraterm sac 0.167-0.213 long, 0.067-0.090 wide, posterior 3/5 non-spiny, anterior part spinose; spines of metraterm and cirrus wedge-shaped 15-17 μ long. Ovary distinctly trilobed, to right of midline, 0.113-0.133 long, 0.063-0.098 wide; seminal receptacle absent; Mehlis' gland posteromedian to cirrus sac; uterus voluminous, mainly posttesticular, entering median side of spinose anterior portion of metraterm sac. Genital atrium unarmed, but appears to be spinose when occupied by partly everted cirrus; genital pore midway between acetabulum and intestinal bifurcation. Eggs numerous, 20-24 by 15-17 μ. Vitellaria in lateral groups of 10-12 follicles, extending from about midacetabular level to ends of ceca. Excretory vesicle tubular; pore terminal.

In both *Diplomonorchis leiostomi* Hopkins, 1941, and *D. bivitellosus* (Manter, 1940) the testes are extracecal and the ceca extend almost to the posterior end of the body whereas in *D. myrophitis* the ceca are overlapped by the testes and terminate a short distance posterior to them. Other differences are the more anterior position of the testes and distribution of the vitellaria in *D. myrophitis*.

Diplomonorchis **micropogoni** n.sp.

Figure 43

Hosts: Micropogon furnieri (J); *Archosargus unimaculatus* (J).

Site: intestine.

Holotype: U.S.N.M. 60286.

Description based on 17 specimens. Body oval to pyriform, 0.233-0.620 long, 0.186-0.420 wide. Entire cuticle spinose; eye-spot pigment present. Oral sucker 0.046-0.083 long, 0.066-0.098 wide; ventral sucker in middle third of body, 0.037-0.067 in diameter; sucker ratio 1:0.61-0.84. Prepharynx absent; pharynx 0.022-0.037 long, 0.027-0.053 wide; ceca terminating near posterior margin of testes. Testes 2, symmetrical, extracecal, immediately postequatorial, 0.054-0.166 long, 0.038-0.080 wide; cirrus sac 0.090-0.180 long, 0.045-0.090 wide, to right of midline, extending short distance posterior to ventral sucker; containing spherical seminal vesicle, short tubular pars prostatica and cirrus with spines. Metraterm sac 0.083-0.105 long, 0.035-0.042 wide, with large, unarmed posterior vesicle and anterior portion with a few spines 6-8 μ long, similar to those of cirrus. Ovary 4-lobed, 0.060-0.165 long, 0.053-0.068 wide, partly anterior to, and partly overlapping level of right testis; uterus voluminous, occupying almost

all available space posterior to intestinal bifurcation; entering metraterm sac near anterior spinose end. Vitelline follicles relatively large, in 2 lateral groups, coinciding with or slightly exceeding zone occupied by gonads. Eggs numerous, thick-shelled, 22-30 by 14-18 μ, usually 24-27 by 15-17. Excretory vesicle tubular; pore terminal.

Worms from some hosts could be separated into 2 size groups but otherwise were identical. The presence of such groups may be expected occasionally because monorchiid cercaria may emerge from, and reenter the same clam to encyst in large numbers. Thus various age groups of adult worms would result from the host's feeding on infected clams at different times.

This species is distinguished from *D. leiostomi* and *D. bivitellosus* by its short ceca and the extent of the uterus. It further differs from *D. bivitellosus* in the distribution of the vitellaria, sucker ratio and egg size, and from *myrophitis* in body shape and size, extracecal position of testes, more extensive uterus and in having fewer spines in the metraterm.

Diplomonorchis **hopkinsi** n.sp.

Figure 44

Host: Micropogon furnieri (J).
Site: intestine.
Holotype: U.S.N.M. 60287.

Description based on 16 specimens. Body oval, 0.247-0.380 long, 0.180-0.233 wide. Entire cuticle spinose; eye-spot pigment absent. Oral sucker 0.040-0.053 long, 0.052-0.070 wide; ventral sucker just within middle third of body length, 0.033-0.039 in diameter; sucker ratio 1:0.65-0.80. Prepharynx absent; pharynx 0.025-0.035 in diameter; esophagus short; ceca extending just posterior to testes. Gonads mainly postequatorial. Testes 2, entire, 0.037-0.068 in diameter, symmetrical to somewhat oblique, mainly extracecal; cirrus sac to right of midline, 0.084-0.130 long, 0.038-0.045 wide, extending at least to midlevel of ovary, containing spherical seminal vesicle, pars prostatica and relatively long spiny cirrus. Metraterm sac indistinct; its spines and those of cirrus minute, difficult to see. Ovary indistinctly 4-lobed. Immediately anterior to right testis which it may overlap; uterus voluminous, filling most available space posterior to intestinal bifurcation, entering metraterm sac near its spinose anterior region. Genital atrium wide, unarmed; genital pore median, approximately midway between acetabulum and intestinal bifurcation. Vitellaria 4-6 follicles on each side, mainly dorsomedian to testes, rarely extending anteriorly to midlevel of ovary. Eggs small, thin-shelled, 13-15 by 9-11 μ. Excretory vesicle tubular; its pore terminal.

This species is named in honor of Prof. S. H. Hopkins. Because it and *D. micropogoni* were found together in the same host individual, they were not immediately recognized as being distinct species. Later we found that *D. hopkinsi* lacked eye-spot pigment, had an indistinct metraterm sac, and contained much smaller eggs. Hopkins did not mention eye-spot pigment in describing *D. leiostomi* but our examination of the type revealed its presence. Cercaria of the Monorchiidae, unlike most other families, may or may not have eye-spots whose pigment can be readily found in the adults. Even so, it is unexpected to find in the same genus, species with or without such pigment, but there may be other such instances as many descriptions are not explicit in that matter.

Diplomonorchis **sphaerovarium** n.sp.

Figures 45 and 46

Host: Spheroides testudineus (J).
Site: intestine.
Holotype: U.S.N.M. 60288.

Description based on 15 specimens. Body oval to elongated, rounded at both ends, 0.984-1.41 long, 0.386-0.579 wide. Entire cuticle spinose, with spines becoming sparse posteriorly; eye-spot pigment present. Large glands in forebody, characteristic of many monorchiids, especially prominent. Oral sucker 0.105-0.120 long, 0.135-0.153 wide; ventral sucker about one-third body length from anterior end, 0.080-0.108 long, 0.099-0.120 wide; sucker ratio 1:0.7-0.82. Prepharynx absent; pharynx 0.054-0.067 in diameter; esophagus shorter than pharynx; ceca relatively long, extending to about middle of posttesticular space. Gonads equatorial. Testes 2, entire, symmetrical, 0.100-0.150 long, 0.068-0.105 wide; cirrus sac elongated, on right, 0.200-0.330 long, 0.066-0.090 wide, extending to ovarian zone, containing large, spherical seminal vesicle, small pars prostatica and cirrus with spines 8-10 μ long. Metraterm sac 0.133-0.226 long, 0.070-

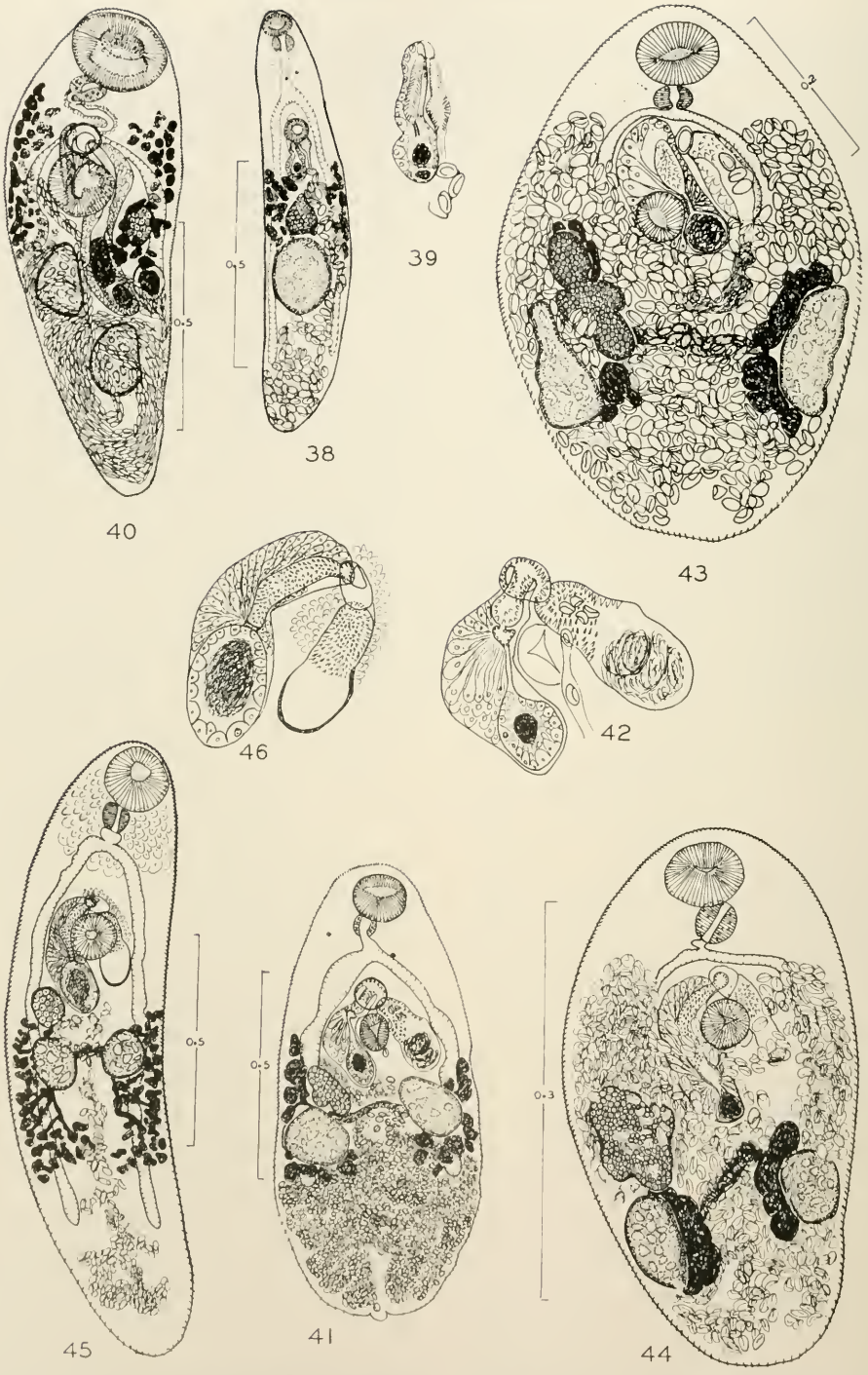


Figure 38. *Hurleytrematoides curacaensis*, holotype, ventral view. **Figure 39.** Same, terminal reproductive organs enlarged. **Figure 40.** *Diplohurleytrematoides brevicaecum*, holotype, ventral view. **Figure 41.** *Diplomonorchis myrophitis*, holotype, ventral view. **Figure 42.** Same, terminal reproductive organs enlarged. **Figure 43.** *Diplomonorchis micropogoni*, holotype, ventral view. **Figure 44.** *Diplomonorchis hopkinsi*, holotype, ventral view. **Figure 45.** *Diplomonorchis sphaerovarium*, holotype, ventral view. **Figure 46.** Same, terminal reproductive organs enlarged.

0.120 wide, with unarmed posterior vesicle and anterior region with spines similar to those of cirrus. Ovary smooth, immediately anterior to right testis, 0.075-0.100 long, 0.067-0.090 wide; uterus mostly posttesticular, entering metraterm sac near middle of spinose portion. Genital atrium unarmed; genital pore median, preacetabular. Vitellaria consisting of 2 lateral groups of numerous follicles, mostly posttesticular. Eggs 24-30 by 16-20 μ. Excretory vesicle long, tubular, extending to ventral sucker; pore terminal.

The present species is referred to *Diplomonorchis* even though the ovary is spherical and not lobed as in other members of the genus. That feature, the more extensive vitellaria, and perhaps much longer excretory vesicle distinguish *D. sphaerovarium* from all other species of *Diplomonorchis*. Together these characteristics may be of generic value but until other species having those features are found, we prefer to broaden the concept of the genus *Diplomonorchis* to include those characters. The genus *Diplomonorcheides* Thomas (1959) would then differ from *Diplomonorchis* only in having a bipartite seminal vesicle.

Diplomonorchis emended

Monorchiidae; subfamily Monorchiinae; body oval to elongated. Cuticle spinose. Ventral sucker in anterior half of body; ceca extending to posterior margin of testes or beyond. Testes 2, usually symmetrical, inter- or extracecal. Cirrus sac with unipartite seminal vesicle, pars prostatica and spiny cirrus. Ovary entire or lobed, pretesticular, to right of midline; metraterm sac present, anterior region spinose; uterus extensive. Genital pore midventral, preacetabular. Vitelline follicles postacetabular, lateral, in gonadal zone. Excretory vesicle tubular. Parasites in intestines of marine fishes. Type species: *D. leiostomi* Hopkins, 1941; other species: *D. brevivitellosus* (Manter, 1940) Hopkins, 1941 (Synonym: *Paramonorcheides brevivitellosus*); **D. myrophitis** n.sp.; **D. micropogoni** s.sp.; **D. hopkinsi** n.sp.; **D. sphaerovarium** n.sp.

Order *Opisthorchiida* La Rue, 1957
Suborder *Opisthorchiata* La Rue, 1957
Superfamily *Opisthorchioidea* (Witenberg, 1929) Vogel, 1930

FAMILY CRYPTOGONIMIDAE Ciurea, 1933

Metadena adglobosa Manter, 1947
Hosts: Lutianus apodus (C, J); **L. aya* (C); *L. griseus* (C, J); **L. jocu* (J); **L. synagris* (J).
Site: ceca and intestine.

Metadena crassulata Linton, 1910
Hosts: Lutianus analis (J); **L. aya* (C).
Site: intestine.

Metadena globosa (Linton, 1910) Manter, 1947
Synonym: Stegopa globosa Linton, 1910.
*Hosts: *Lutianus apodus* (J); *L. aya* (C); *Ocyurus chrysurus* (J).
Site: intestine.

Paracryptogonimus neoamericanus Siddiqi & Cable, 1960
Hosts: Lutianus aya (C); *Ocyurus chrysurus* (C).
Site: intestine.
Certain dimensions given by Siddiqi and Cable (1960) are extended by a single specimen found in *L. aya*. It measures 1.293 by 0.772 and has oral spines up to 26 μ long.

Siphodera vinaledwardsii (Linton, 1899) Linton, 1910
Synonym: Monostomum vinaledwardsii Linton, 1899.
Hosts: Lutianus analis (C, J); **L. aya* (C); **L. buccanella* (C); *L. synagris* (J); *Ocyurus chrysurus* (C, J).
Site: intestine.

FAMILY HETEROPHYIDAE Odhner, 1914

Scaphanocephalus sp.
Host: Epinephelus striatus (J).
Site: intestine.
The single specimen was large and well developed but lacked eggs. It probably was a recently ingested metacercaria that had excysted in the intestine of the fish but could not have persisted and matured there. The genus *Scaphanocephalus* is closely related to *Galactosomum* and species of both genera are parasites of piscivorous birds.

Suborder *Acanthocolpiata* n.subo.
Superfamily *Acanthocolpoidea* n.superf.
FAMILY ACANTHOCOLPIDAE Lühe, 1909

After La Rue (1957) placed the family Acanthocolpidae in the superfamily Allo-

creadioidea of the suborder Plagiorchiata, Peters (1961) described the embryology of the cercarial excretory system and, on that basis, suggested a closer affinity of that family with the Echinostomatoidea. The morphology of their adults is indeed very similar as is also the development of the excretory system in their cercariae, except that the bladder is large and epithelial in the Acanthocolpidae whereas the echinostomes have a small bladder that lacks an epithelium. In that respect and in the location of the primary excretory pores, the embryology of the excretory system in acanthocolpids agrees with that of cercariae of the order Opisthorchiida as characterized by La Rue. However, differences in both larval and adult morphology exceed those occurring between families, superfamilies or even suborders of La Rue's scheme. For that reason, a new suborder is proposed and characterized as follows:

Suborder *Acanthocolpiata*

Spinose, distomatous trematodes with biocellate cercaria developing in rediae in marine prosobranch gastropods. Excretory system stenostomate; primary pores of cercarial embryo in tail, well removed from body-tail furrow; excretory vesicle sac- to Y-shaped with short arms, wall with conspicuous granular cells. Cercaria with well-developed suckers; oral sucker not protrusible, with or without stylet. Tail well-developed, with or without longitudinal fins, possibly zygocercous or otherwise modified in species whose life histories are unknown. Metacercariae in fishes.

The new superfamily has the characters of the suborder but is not further characterized at this time because of the possibility that it will eventually include the Campulidae. No life histories in that family have yet been determined. However, its affinity with the acanthocolpids is strongly suggested by unpublished studies made in this laboratory concerning the adult morpohlogy of *Orthosplanchnus fraterculus,* a campulid from the gall bladder of the sea otter, *Enhydra lutris.*

Stephanostomum casum (Linton, 1910) McFarlane, 1936

Synonyms: Stephanochasmus casus Linton, 1910; *Lechradena edentula* Linton, 1910

*Hosts: *Lutianus aya* (C); **L. buccanella* (C), **L. synagris* (J).

Site: intestine.

Stephanostomum coryphaenae Manter, 1947

Host: Coryphaena hippurus (C).

Site: intestine.

Stephanostomum dentatum (Linton, 1900) Manter, 1931

Synonym: Distomum dentatum Linton, 1900.

Hosts: Epinephelus striatus (J); **Mycteroperca bonaci* (C).

Site: intestine.

Stephanostomum sentum (Linton, 1910) Manter, 1947

Synonym: Stephanochasmus sentus Linton, 1910.

*Hosts: *Anisotremus virginicus* (J); **Caranx latus* (J); *Gerres cinereus* (C); **Haemulon album* (C); *H. sciurus* (J); **Lutianus* sp. (C).

Site: intestine.

Stephanostomum ditrematis (Yamaguti, 1939) Manter, 1947

Synonyms: Echinostephanus ditrematis Yamaguti, 1939; *Stephanostomum longisomum* Manter, 1940; *Stephanostomum filiforme* Linton, 1940.

*Hosts: *Caranx bartholomaei* (J); **C. crysos* (J); *C. hippos* (J); *C. latus* (J); **Caranx* sp. (C).

Site: intestine.

Stephanostomum pseudocarangis Sogandares-Bernal, 1959

Host: Holocentrus ascensionis (J).

Site: intestine.

Stephanostomum megacephalum Manter, 1940

Host: Caranx latus (J).

Site: intestine.

Stephanostomum **aulostomi** n.sp.

Figures 47 and 48

Host: Aulostomus maculatus (C).

Site: junction of stomach and intestine.

Holotype: U.S.N.M. 60289.

Description based on one complete and 2 incomplete specimens. Body elongated, 6.37 long, 0.547-0.667 in maximum width at level of acetabulum. Entire cuticle spinose, spines becoming sparse posteriorly; eye-spot pig-

ment present. Oral sucker 0.193 by 0.273, with 36 perioral spines 21-37 by 11-15 μ, alternating in 2 rows of 18 each; ventral sucker 0.333-0.387 in diameter; sucker ratio 1:1.6. Prepharynx 0.700 long; pharynx 0.300-0.334 long, 0.167-0.180 wide; esophagus short; intestinal bifurcation close to acetabulum; ceca extending to near posterior end of body, joining excretory vesicle to form uroproct; feces seen discharged from terminal pore. Gonads in posterior third of body. Testes 2, 0.360-0.587 long, 0.187-0.234 wide, tandem, separated by vitelline follicles. Cirrus sac long, not quite reaching midway between acetabulum and ovary, containing saccate seminal vesicle, pars prostatica and long spiny cirrus. Ovary 0.300-0.327 long, 0.253-0.267 wide, anterior to, and separated from testes by vitelline follicles; uterine seminal receptacle, Mehlis' gland and uterus preovarian; metraterm well-developed, without spines, joining male duct near posterior margin of acetabulum. Genital atrium tubular; genital pore immediately preacetabular. Eggs 60-75 by 45-51 μ. Vitelline follicles extending from posterior end of body to near posterior margin of ventral sucker. Excretory vesicle obscured by vitellaria.

The combination of 2 uninterrupted rows of 18 oral spines each and vitellaria that extend to near the posterior margin of the ventral sucker distinguishes *S. aulostomi* from most species of *Stephanostomum*. It differs from *S. casum* in having a more elongated body, more anterior testes, less posterior extent of the cirrus sac and gonads separated by vitelline follicles; and from *S. coryphaenae* chiefly in the shape of the cirrus sac, more anterior extent of the vitellaria, and in having a much longer genital atrium and somewhat wider eggs.

In habitat, *S. aulostomi* is unusual, with the oral sucker anchored just above the pyloric sphincter of the host and most of the body in the duodenum. Thus it was not until the digestive tract was opened without separating the stomach and intestine that a complete specimen was obtained.

Stephanostomum metacercaria

Host: Cypselurus bahiensis (C).
Site: cyst on gill arch.

The single acanthocolpid metacercaria found in this study had an oral sucker that was smaller than the acetabulum and 48 perioral spines in 2 uninterrupted rows.

Tormopsolus orientalis Yamaguti, 1934
*Host: *Seriola dumerili* (C).
Site: intestine.

Manteria brachydera (Manter, 1940) Caballero, 1950

Synonyms: Dihemistephanus bachyderus Manter, 1940; *Stephanostomum* sp. Linton, 1940.
Host: Oligoplitis saurus (J).
Site: intestine.

Suborder *Hemiurata* Skrjabin & Guschanskaja, 1954
Superfamily *Hemiuroidea* Faust, 1929
FAMILY HEMIURIDAE Lühe, 1901

Parahemiurus merus (Linton, 1910) Woolcock, 1935

Synonyms: Hemiurus merus Linton, 1910; *Parahemiurus parahemiurus* Vaz & Pereira, 1930; *P. platichthyi* Lloyd, 1938; *P. atherinae Yamaguti,* 1938; P. *harengulae* Yamaguti, 1938.

Hosts: Abudefduf saxatilis (J); **Caranx crysos* (J); **C. hippos* (J); **C. latus* (J); **Echeneis naucrates* (C); *Opisthonema oglinum* (J); **Sardinella anchovia* (C, J); *S. macrophthalmus* (J); **Seriola dumerili* (J).
Site: stomach.

Sterrhurus fusiformis (Lühe, 1901) Looss, 1907

Synonym: Lecithochirium fusiformis Lühe, 1901.

Hosts: Gymnothorax moringa (C, J); **G. vicinus* (C).
Site: stomach.

Sterrhurus musculus Looss, 1907

Synonyms: Sterrhurus floridensis Manter, 1934, in part; *Sterrhurus laeve* (Linton) of Manter, 1931.

*Hosts: *Achirus lineatus* (J); **Epinephelus adscensionis* (C); **E. morio* (C); **Haemulon album* (C); **H. sciurus* (J); *Holocentrus ascensionis* (C, J); **H. vexillarius* (J); **Leptocephalus conger* (J); **Lutianus apodus* (C); **L. aya* (C); **L. griseus* (C); *Malacanthus plumieri* (J); **Platophrys lunatus* (C, J); **Prionotus punctatus* (J); **Rypticus saponaceus* (C); *Scorpaena plumieri* (C, J); **Selar crume-*

nophthalmus (J); *Synodus intermedius* (C, J); **Trachinotus glaucus* (J).
Site: stomach.

Lecithochirium microstomum Chandler, 1935
Synonym: Lecithochirium sinaloense Bravo-Hollis, 1956.
Hosts: Synodus intermedius (J); **Selar crumenophthalmus* (J); **Seriola dumerili* (J).
Site: stomach.

Lecithochirium parvum Manter, 1947
Synonym: Sterrhurus floridensis Manter, 1934, in part.
Hosts: **Abudefduf saxatilis* (J); **Bathystoma striatum* (J); **Caranx bartholomaei* (J); **C. latus* (J); **C. hippos* (C, J); **Dules dispilurus* (J); **Epinephelus adscensionis* (J); **Holocentrus ascensionis* (J); **Lutianus apodus* (C); **L. aya* (C); **L. griseus* (J); **Sardinella macrophthalmus* (J); **Scorpaena plumieri* (J); **Selar crumenophthalmus* (J); **Seriola dumerili* (C, J); **Upeneus martinicus* (J); *Synodus intermedius* (J).
Site: stomach.

Ectenurus americanus (Manter, 1947) Manter & Pritchard, 1960
Synonyms: Parectenurus americanus Manter, 1947; *Magnacetabulum americanum* (Manter) Yamaguti, 1954.
Hosts: Caranx bartholomaei (J); **C. crysos* (J); **C. hippos* (J); **Epinephelus striatus* (J); **Selar crumenophthalmus* (J); **Seriola dumerili* (J); **Synodus intermedius* (J).
Site: stomach.

Ectenurus virgulus Linton, 1910
Hosts: **Caranx bartholomaei* (J); **C. hippos* (J); **Priacanthus cruentatus* (C); *Sardinella macrophthalmus* (J); *Selar crumenophthalmus* (J); **Trachinotus glaucus* (J).
Site: intestine.

Dinurus barbatus (Cohn, 1902) Looss, 1907
Synonym: Lecithocladium barbatum Cohn, 1902.
Host: Coryphaena hippurus (C).
Site: stomach.

Dinurus breviductus Looss, 1907
Host: Coryphaena hippurus (C).
Site: stomach.

Dinurus tornatus (Rudolphi, 1819) Looss, 1907
Synonyms: Distomum tornatum Rudolphi, 1819; *Lecithocladium tornatum* (Rud.) Lühe, 1901.
Host: Coryphaena hippurus (C).
Site: stomach.

Stomachicola rubea (Linton, 1910) Manter, 1947
Synonyms: Dinurus rubeus Linton, 1910; *Pseudostomachicola rubea* (Linton) Skrjabin & Guschanskaja, 1954.
Hosts: Gymnothorax moringa (J); **G. vicinus* (J).
Site: stomach.

Neogenolinea opisthonemae Siddiqi & Cable, 1960
Hosts: Opisthonema oglinum (J); **Sardinella anchovia* (J); **S. macrophthalmus* (J).
Site: stomach.

Brachadena pyriformis Linton, 1910
Synonyms: "Distomum bothryophoron Olsson" of Linton, 1905; *Lecithaster anisotremi* MacCallum, 1921; *L. gibbosus* (Rud.) of Linton, 1940 in part; ***Aponurus symmetrorchis* Siddiqi & Cable, 1960.
Hosts: Anisotremus virginicus (J); **Archosargus unimaculatus* (J); *Bathystoma striatum* (J); *Calamus bajanado* (J); **Eucinostomus pseudogula* (J); **Haemulon bonariense* (J); **H. flavolineatum* (C, J); *H. sciurus* (J).
Site: stomach.

A reexamination of the type and paratypes of *Aponurus symmeterorchis* Siddiqi and Cable, 1960, reveals that the vitellaria unite centrally, a characteristic of the genus *Brachadena,* and the measurements given overlap those of *Brachadena pyriformis.*

Genolinea **noblei** n.sp.
Figure 49
Host: Abudefduf saxatilis (C).
Site: stomach.
Holotype: U.S.N.M. 60290.

Description based on a single specimen. Body thick, rounded at both ends, 1.25 long, 0.367 wide. Oral sucker subterminal, 0.087 long, 0.082 wide, surmounted by conspicuous fleshy lobe; ventral sucker 0.227 long, 0.213 wide, with longitudinal aperture; sucker ratio 1:2.59. Prepharynx absent; pharynx 0.045 long, 0.063 wide; esophagus

absent; ceca wide, extending to near posterior end of body. Testes 2, entire, slightly diagonal, 0.075 long, 0.083-0.090 wide, separated by uterine coils; seminal vesicle long, sinuous, not reaching midlevel of acetabulum, with 4 conspicuous swellings connected by narrow ducts; prostate vesicle ovoid, 0.045 long, 0.030 wide, surrounded by prostate cells; duct very short. Ovary entire, 0.060 long, 0.105 wide, posterior to, and separated from testes by uterine coils; Mehlis' gland dorsal to vitellaria; seminal receptacle not evident, possibly concealed by uterus and ceca; uterus extending to near posterior end of body; metraterm well-developed, spiny, joining prostatic duct at base of sinus sac. Hermaphroditic duct with swollen posterior region and elongated anterior portion. Sinus sac apparently of open or incomplete type. Genital pore ventral, opposite intestinal bifurcation. Eggs 28-33 by 10-12 μ. Vitellaria 2 compact, tandem masses immediately postovarian. Excretory vesicle short, lined with epithelial cells; excretory ducts uniting dorsal to pharynx.

The spiny metraterm and longitudinal aperture of the acetabulum distinguish this species from all others in the genus *Genolinea*. *G. tanyopa* Montgomery, 1957, has a longitudinal aperture but differs from *G. noblei* in sucker ratio, posterior extent of the seminal vesicle, nature of the sinus sac and also in having a much longer prostatic duct.

The species is named in honor of the late Alden E. Noble of the University of the Pacific in recognition of his contributions to trematodology.

Aponurus elongatus Siddiqi & Cable, 1960
Synonym: Aponurus sp. Linton, 1940.
Host: Chaetodipterus faber (J).
Site: stomach.

Leurodera decora Linton, 1910
Hosts: Anisotremus virginicus (J); *Haemulon flavolineatum* (J); *H. sciurus* (J).
Site: stomach.

Dichadena acuta Linton, 1910
Synonym: Lecithaster acutus (Linton) Manter, 1947.
Hosts: Acanthurus bahianus (C); *A. coeruleus* (J); *A. hepatus* (C, J).
Site: stomach.

Macradena perfecta Linton, 1910
Host: **Acanthurus hepatus* (C, J).
Site: stomach.

Hysterolecitha rosea Linton, 1910
Host: Acanthurus hepatus (J).
Site: stomach.

Hysterolecitha **sogandaresi** n.sp.
Figure 50

Host: Acanthurus coeruleus (J).
Site: stomach.
Holotype: U.S.N.M. 60291.

Description based on 3 specimens. Body non-appendiculate, tapering posteriorly, 1.54-2.22 long, 0.467-0.533 in maximum width at level of acetabulum. Oral sucker subterminal, 0.147-0.173 long, 0.167-0.220 wide; ventral sucker near midbody, 0.367-0.433 long, 0.387-0.400 wide; sucker ratio 1:2.14-2.33. Prepharynx absent; pharynx 0.060-0.070 long, 0.070-0.090 wide; esophagus very short; ceca swollen near intestinal bifurcation, extending to near posterior end of body. Testes 2, entire, diagonal (nearly tandem in one specimen), 0.082-0.123 in diameter; anterior testis somewhat dorsal to acetabulum; seminal vesicle long, coiled tube, mostly anterior to ventral sucker; pars prostatica short, surrounded by prostate cells. Ovary entire, submedian, posttesticular, 0.068-0.105 in diameter, usually overlapping posterior level of testes; uterus extending to near tips of ceca; metraterm simple, joining short prostatic duct at base of small, spherical sinus sac. Hermaphroditic duct short. Genital pore median, ventral, some distance posterior to intestinal bifurcation. Eggs numerous, 26-31 by 15-19 μ. Vitellaria of 7 subglobular follicles, immediately postovarian. Excretory arms uniting dorsal to pharynx; excretory pore terminal.

Of the 11 species described in *Hysterolecitha*, *H. sogandaresi* is most similar to *H. acanthuri* Annereaux, 1947, from a related host in the Phillippines but differs from that species in having testes closer to the acetabulum, a shorter prostatic duct and more compact vitellaria.

This species is named in honor of Dr. Franklin Sogandares in recognition of his contributions to knowledge of the Trematoda.

Theletrum **pomacentri** n.sp.

Figure 51

Host: Pomacentrus leucosticus (J).
Site: stomach.
Holotype: U.S.N.M. 60292.

Description based on a single specimen. Body non-appendiculate, tapering posteriorly, 1.54 long, 0.500 in maximum width at level of acetabulum; forebody 0.413 long, hindbody 0.865. Oral sucker 0.099 long, 0.105 wide; ventral sucker 0.262 long, 0.240 wide, with longitudinal aperture; sucker ratio 1:2.43. Prepharynx absent; pharynx spherical, 0.054 in diameter; esophagus short; ceca extending to near posterior end of body. Testes smooth, diagonal, 0.075-0.090 in diameter; seminal vesicle coiled, tubular, mostly preacetabular; prostate vesicle reniform, surrounded by poorly-developed prostate cells. Ovary bilobed, 0.060 long, 0.135 wide, posterior to, and separated from testes by coils of uterus; Mehlis' gland not evident; uterus voluminous, not reaching ends of ceca; metraterm simple, ventral to seminal vesicle, joining very short prostatic duct at base of sinus sac. Hermaphroditic duct widest anteriorly; sinus sac subglobular, 0.060 by 0.075. Genital pore midventral, posterior to intestinal bifurcation. Eggs numerous, 27-30 by 10-12 μ. Vitellaria immediately postovarian; in 3 compact masses with 2 anterior ones possibly connected by an isthmus; posterior mass slightly indented. Excretory system not observed.

Theletrum pomacentri differs from all the other species in the genus in having a bilobed ovary. It further differs from *T. fustiforme* Linton, 1910, in lacking the postacetabular fold and in having 3 rather than 2 vitelline masses; from *T. gravidum* Manter, 1940, in sucker ratio and shape and extent of seminal vesicle; from *T. lissosomum* Manter, 1940, in sucker ratio; and from *T. magnasaccum* Sogandares-Bernal and Sogandares, 1961, in shape and extent of the seminal vesicle, shape of the sinus sac and in the position of the genital pore.

The type specimen was damaged after it was studied and drawn.

In Jamaica and especially Curaçao, surgeon fish were commonly infected with a monorchid hemiurid which otherwise resembled species of *Macradena*. To receive that species, a new genus is proposed and characterized as follows:

Monorchimacradena n.g.

Hemiuridae. Medium size distomes without ecsoma. Cuticle smooth. Oral sucker subterminal; ventral sucker preequatorial. Ceca extending to near posterior end of body. Testis single; seminal vesicle postacetabular; pars prostatica long, tubular, mostly posterior to ventral sucker, surrounded by prostate cells. Sinus sac present. Ovary entire, posttesticular; seminal receptacle present. Vitellaria of elongated lobes, postovarian. Eggs small and numerous. Excretory commissure present. Parasitic in intestine of marine fish. Type and only species:

Monorchimacradena acanthuri n.g., n.sp.

Figure 52

Host: Acanthurus hepatus (C, J).
Site: intestine.
Holotype: U.S.N.M. 60293.

Description based on 38 specimens; measurements on 10. Body usually elongated, 1.1-2.57 long, 0.240-0.374 in maximum width at level of acetabulum. Oral sucker subterminal, 0.082-0.145 long, 0.105-0.180 wide; preoral lobe fleshy, often expanded, resembling head of a planarian, especially noticeable in living specimens. Ventral sucker in anterior third or fourth of body, 0.150-0.266 in diameter, aperture transverse; sucker ratio 1:1.3-1.8. Prepharynx absent; pharynx 0.060-0.097 in diameter; esophagus about same length as pharynx; ceca without epithelium for a short distance from intestinal bifurcation, ending blindly near posterior end of body. Testis about equatorial, 0.105-0.200 long, 0.068-0.130 wide; seminal vesicle sac-like, immediately pretesticular; pars prostatica long, tubular, usually in hindbody, sometimes partly dorsal to ventral sucker, surrounded by conspicuous prostate cells along entire length; ejaculatory duct as long as pars prostatica when not contracted. Ovary smooth, 0.045-0.160 in diameter, immediately posttesticular; seminal receptacle as large or larger than ovary; uterus extending to near posterior extremity; metraterm simple, joining pars prostatica at base of sinus sac. Hermaphroditic duct wide. Sinus sac spherical to pyriform, 0.060-0.112 in diameter. Genital pore midventral, posterior to intestinal bifurcation. Eggs numerous, 20-28 by 9-15 μ. Vitellaria immediately postovarian, of 7 digitiform or

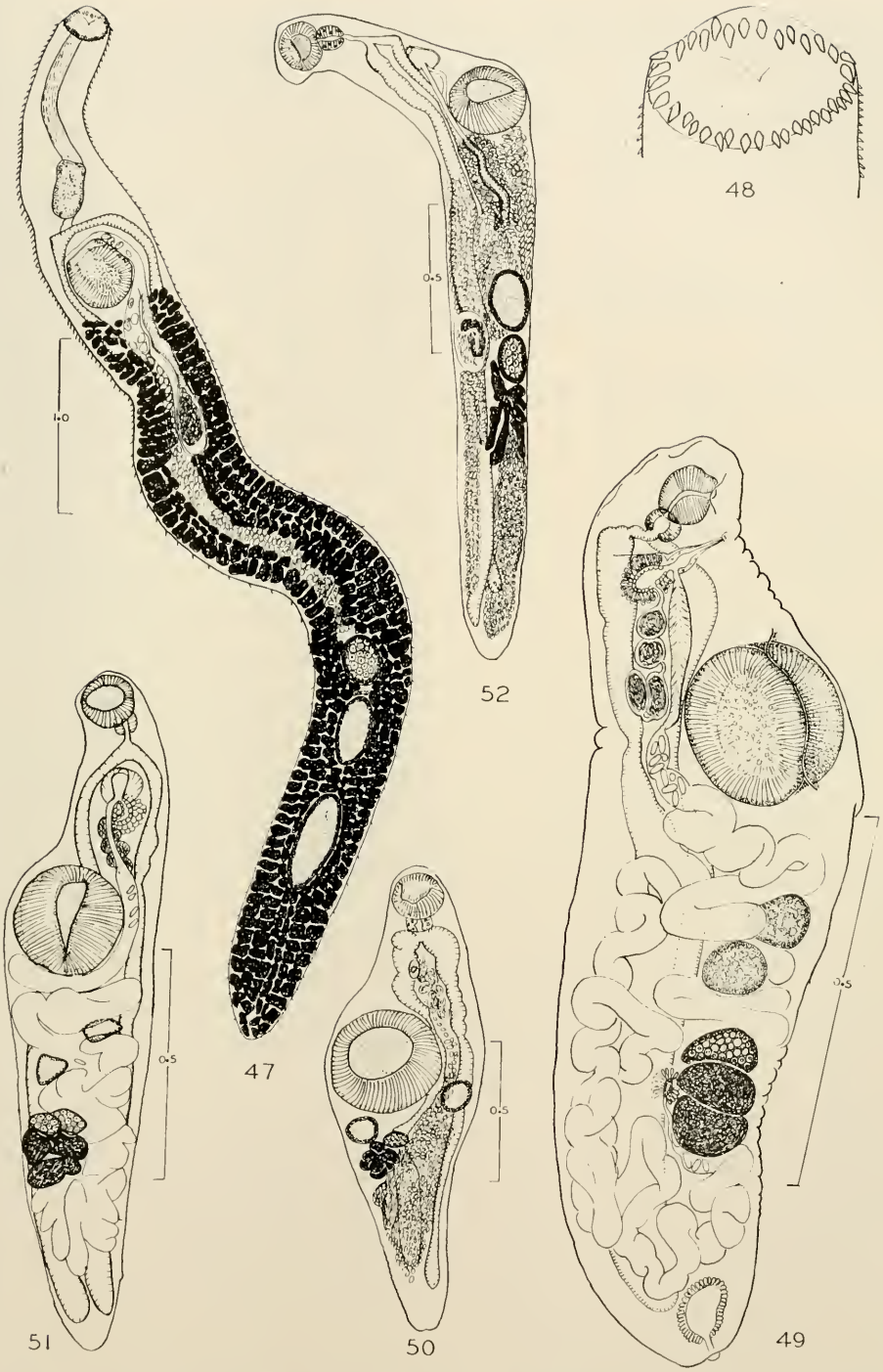


Figure 47. *Stephanostomum aulostomi*, holotype, dorsal view. **Figure 48.** Same, anterior end enlarged. **Figure 49.** *Genolinea noblei*, holotype, ventrolateral view. **Figure 50.** *Hysterolecitha sogandaresi*, holotype, ventral view. **Figure 51.** *Theletrum pomacentri*, holotype, ventral view. **Figure 52.** *Monorchimacradena acanthuri*, holotype, ventral view.

slightly branched lobes, united centrally. Excretory system with commissure dorsal to pharynx; pore terminal.

Dictysarca virens Linton, 1910
Hosts: Gymnothorax funebris (J); *G. moringa* (J); **G. vicinus* (J).
Site: swim bladder.

FAMILY ACCACOELIIDAE Looss, 1912

Tetrochetus coryphaenae Yamaguti, 1934
Hosts: Coryphaena hippurus (C); **Diodon hystrix* (J).
Site: intestine.

FAMILY HIRUDINELLIDAE Dollfus, 1932

Hirudinella sp.
Host: Scorpaena plumieri (C).
Site: stomach.
A single immature specimen was taken from the stomach of a scorpion fish.

FAMILY SCLERODISTOMIDAE Dollfus, 1932

Sclerodistomum sphoeroidis Manter, 1947
Host: **Diodon hystrix* (C, J).
Site: stomach.

FAMILY PROSOGONOTREMATIDAE Pérez Vigueras, 1940

Prosogonotrema bilabiatum Pérez Vigueras, 1940
Host: Ocyurus chrysurus (J).
Site: stomach.

V. Geographical Distribution

The geographical distribution of the digenetic trematodes of marine fishes in the Gulf-Caribbean region has been discussed by a number of investigators. Manter (1940b, 1947, 1955) included them in reviewing the zoogeography of the group on a world-wide basis. A more limited approach was that of Sparks (1960) who concluded that the "hydrographic, climatological, physiographic and geological conditions existing both now and in the past in the northern gulf" are responsible for the differences seen between the trematode faunas of the Dry Tortugas and Grand Isle, Louisiana. Siddiqi and Cable (1960) discussed geographical distribution and the related factors of isolation, speciation and host specificity. They compared the trematode fauna of Puerto Rico with that of Tortugas, Bermuda, Galapagos Islands, Woods Hole, Beaufort and Hawaii and found that the per cent of Puerto Rican species common also to each of those localities decreased in the order listed, from a maximum of 76% at Tortugas.

The present study provides data from 2 additional localities in the Caribbean region. Table 1 compares by families the number of new and previously described species from those localities. With respect to the total found there, the differences in their trematode faunas are striking in certain families. Curaçao is notably poor in fellodistomatid species where but 3, all previously known and widely distributed, were found in 4 of 124 species of fishes. In contrast, 12 species of fellodistomatids were found in Jamaica where 127 species of fishes were examined. The difference may be due to the limited variety of habitats in Curaçao for lamellibranch molluscs which serve as intermediate hosts of the fellodistomatids. On the other hand the richness of such habitats in Jamaica and the life history pattern in that family would seem to favor speciation in the group as indicated by the discovery there of 4 new species. In known life histories, fellodistomatid metacercariae occur in molluscs or possibly amphipods and would be ingested only by birds feeding in shallow water or by bottom-feeding fishes where the food source could serve to isolate populations of shallow water host species.

The same may be observed concerning the family Lepocreadiidae except that in it, gastropods serve as the mulluscan hosts. Their relative abundance and variety in Curaçao, as compared with lamellibranchs, is reflected in the discovery there of 5 new lepocreadiids, whereas 6 were found in Jamaica. A comparable situation with respect to new species of monorchiids, which have lamellibranch molluscan hosts, seems to contradict what was said above concerning the fellodistomatids but may be explained by a lower degree of specificity of the monorchiids for those hosts. For example, *Cercaria caribbea XXXVI*, a monorchid larva, occurs in at least 2 distantly related species of bivalves in different localities.

Curaçao is rather removed from other Gulf-Caribbean areas that have been investigated. The number of known trema-

TABLE 1.
Distribution of Digenetic Trematode Species.

Family	Number of Species						
	total	Curaçao old	Curaçao new	Jamaica old	Jamaica new	common to both localities old	common to both localities new
Aspidogastridae	2	0	0	2	0	0	
Acanthocolpidae	10	6	1	7	0	4	
Accacoeliidae	1	1	0	1	0	1	
Bivesiculidae	1	0	1	0	1	0	1
Bucephalidae	15	12	1	10	0	8	
Cryptogonimidae	5	5	0	4	0	4	
Fellodistomatidae	12	3	0	8	4	3	
Gorgoderidae	2	1	0	1	1	1	
Hemiuridae	23	11	2	16	3	8	1
Haploporidae	4	1	0	4	0	1	
Haplosplanchnidae	11	6	3	5	3	5	1
Lepocreadiidae	36	11	5	22	6	6	2
Megaperidae	3	2	0	1	1	1	
Microphallidae	2	2	0	0	0	0	
Monorchiidae	17	6	4	8	5	6	
Opecoelidae	21	8	3	16	0	6	
Opistholebetidae	2	1	0	2	0	1	
Paramphistomatidae	1	0	0	1	0	0	
Pronocephalidae	1	0	0	1	0	0	
Prosogonotrematidae	1	0	0	1	0	0	
Sclerodistomatidae	1	1	0	1	0	1	
Zoogonidae	7	4	0	4	1	2	
	178	80	20	115	25	57	5

Not included in this table are *Stephanostomum* metacercaria, *Hirudinella* sp. (immature), *Scaphanocephalus* sp., and *Alcicornis siddiqii.*

tode species found there, however, reflects its nearness to the mainland, along the coast of which many such species probably have a continuous distribution toward both Central America and eastward along the South American coast. Other species are cosmopolitan parasites of far-ranging fishes throughout the region. However, a degree of isolation is suggested by the number of new species in certain families including those discussed above, and by the absence of certain others. Thus 3 of 11 opecoelids found in Curaçao are new whereas all of 16 Jamaican species are known ones. On the other hand, the opecoelids, *Hamacreadium mutabile* and *Helicometrina nimia,* were not found in Curaçao although numbers of their host species were examined. The same was observed for several other species indicated by a dagger in the Host-Parasite List.

Table 2 includes, by family, the number of species common to each of several localities and Tortugas where 146 species are known excluding those reported from deep-water fishes. Cuba is not included in the table because Pérez Vigueras described as new several species which were not adequately compared with known ones and probably are not distinct from them. Most similar to the trematode fauna of Tortugas is that of the Bahamas (Bimini, Nassau and Eleuthera) and Bermuda, as is to be expected from their relationship to the Gulf Stream. When Jamaica and Curaçao are compared with Tortugas, the percent of their trematode species in common with that locality is the same even though Curaçao is much farther from Tortugas. The somewhat lower percentage for Puerto Rico reflects its isolated position at the eastern end of the Greater Antilles chain. Differences in the trematode faunas of the northern Gulf of Mexico and Tortugas have been discussed by Sparks (1960) and are indicated by the percentages given in Table 2. The physiographic factors which he stressed probably determine the distributional limits not only of definitive host species but perhaps more significantly those of molluscan hosts as well. Several molluscs that harbor a variety of larval trematodes throughout

TABLE 2.

Resemblance of the trematodes of marine fishes from the Gulf-Caribbean areas to those of Tortugas, Florida, as indicated by the number of species common to both localities.

Family	Dry Tortugas (146)*	Nassau, Eleuthera (22)*	Bimini (60)*	Jamaica (140)*	Puerto Rico (123)*	Curaçao (100)*	Bermuda (43)*	Grand Isle, La. (44)*	Boca Ciega & Tampa Bays (30)*
Aspidogastridae	1		1	1			1	1	
Acanthocolpidae	7	2	4	5	4	5	2	2	2
Accacoeliidae	1		1	1		1		1	
Bivesiculidae	1		1		1				
Bucephalidae	13	1	3	5	3	7	1		1
Cryptogonimidae	4	1	3	4	2	4	2	1	1
Fellodistomatidae	9	1	4	7	4	3	1		1
Gorgoderidae	2			1	1	1	1		
Hemiuridae	32	3	9	14	14	11	4	14	4
Hirudinellidae	1	1			1				
Haploporidae	4	2		2		1	1	1	
Haplosplanchnidae	7		1	4	3	4	2		
Lepocreadiidae	16		7	11	7	3	5	1	1
Megaperidae	4		2	1	3	2	1		
Microphallidae									
Monorchiidae	9	1	2	7	4	5	2		
Opecoelidae	21	7	7	10	9	6	1		
Opistholebetidae	2			1	1		1		
Paramphistomatidae	1		1		1				
Pronocephalidae	2		1	1	2		1		
Sclerodistomatidae	1			1		1			1
Zoogonidae	8		1	3		3	2		1
Total	146	19	48	79	60	57	28	21	12
Percent of species in common	100	89	80	57	50	57	65	48	40

*Number in parenthesis following locality indicates total number of trematode species known from that area.

the Caribbean region disappear before reaching the latitude of Boca Ciega Bay or Grand Isle in the Gulf of Mexico. Hence adults of trematodes that are specific for such molluscs would not be found in non-migratory hosts north of that latitude. A notable exception to that situation allows the cryptogonimid, *Siphodera vinaledwardsii*, to occur from Cape Cod to Curaçao at least. That species has as its molluscan host snails that are very similar if not the same species throughout that range. However, north of Tortugas, whether along the Atlantic or Gulf coasts, the definitive host is a toadfish which is replaced by very different fishes, the snappers, from Tortugas southward.

VI. HOST SPECIFICITY

Because the host is the immediate environment of the parasite, host specificity as well as distribution is an isolating factor of major importance in the zoogeography of parasites in general. Manter (1957) summarized the extent to which digenetic trematodes have been reported from one or more species of marine fishes in Japan, Tortugas, the Mediterranean, and the British Isles. According to him, the trematodes found in but one host species ranged from 48% of the known species in the British Isles to 76.4% in Japan; the average for all localities, calculated from Manter's data, is 60.9% and that for Curaçao and Jamaica combined

TABLE 3.

Host specificity of trematodes from Curaçao and Jamaica for species, genera, and families of marine fishes.

Family of Trematodes	Number of Species	Number of Host																	
		Species						Genera						Families					
		1	2	3	4	5	5+	1	2	3	4	5	5+	1	2	3	4	5	5+
Aspidogastridae	2	2						2						2					
Acanthocolpidae	10	6	1	1		1	1	8	1			1		9			1		
Accacoeliidae	1		1						1						1				
Bivesiculidae	1	1						1						1					
Bucephalidae	15	11	2	1			1	14		1				15					
Cryptogonimidae	5		2	1		2		2	3					5					
Fellodistomatidae	12	8	3				1	11			1			11	1				
Gorgoderidae	2	1				1		1				1		1				1	
Hemiuridae	23	10	2	5			6	14	2	1		2	4	16	1	3	1		2
Haploporidae	4	1	2	1				2	2					3	1				
Haplosplanchnidae	11	5	1	1	3		1	7	2	1	1			10			1		
Lepocreadiidae	36	25	7	2	1	1		34	1	1				34	2				
Megaperidae	3	2		1				3						3					
Microphallidae	2	1	1					2						2					
Monorchiidae	17	10	3		2		2	11	5			1		14	2	1			
Opecoelidae	21	12	5	2			2	19				1	1	19	1				1
Opistholebetidae	2	1		1				1	1					2					
Paramphistomatidae	1	1						1						1					
Pronocephalidae	1		1					1						1					
Prosogonotrematidae	1	1						1						1					
Sclerodistomatidae	1	1						1						1					
Zoogonidae	7	5	1	1				5	1	1				5	2				
Totals	178	104	32	17	6	5	14	141	19	5	2	6	5	156	11	4	3	1	3

is 59%. Trematodes recovered from 2 host species varied between 12.1% in Japan to 22.6% in Tortugas with an average of 17.7% compared with 18% in the present study. For 3 host species, the number ranged from 6.76% in Japan to 9.3% in the British Isles, and averaged 7.74% as compared with 9.5% in Curaçao and Jamaica. For 4 hosts, the range was from 1.68% in Japan to 6.6% in the British Isles, averaging 3.7% which is very close to 3.4% calculated from the present study. From 3% of the trematode species in Japan to 18.6% in the British Isles have been reported from 5 or more host species, with an average of 9.77%; present data show 10.6% in Curaçao and Jamaica.

The above data indicate a rather high degree of host specificity for trematodes of marine fishes but do not take into account the differences between trematode families or the degree to which more than one host species of a trematode may be related. Those aspects are included in Table 3 from which the above calculations for Curaçao and Jamaica were made. In it, each trematode family is analyzed according to the number of its species found in various host species, genera and families. Although certain trematode families are represented by only one or a few species, the table shows in general that when host species are grouped into higher taxa, viz., genera and families, the number of trematode species reported from hosts belonging to more than one such taxon progressively decreases. On that basis, hemiurid species are least host specific whereas the lepocreadiids show the opposite extreme. The striking difference between those groups probably is correlated with the localization of the majority of hemiurids in the stomachs of their hosts whereas all of the lepocreadiids reported in this study are intestinal parasites. Another factor is how much the parasite must grow and develop to mature after reaching the host; in this case it is less in the hemiurids than the lepocreadiids. A group with even more advanced metacercariae than the hemiurids is the microphallids, of which one species, previously known only from birds, is here reported from snake-eels. Until trematode life histories and the food habits of potential hosts are better known, it will be impossible to distinguish trematodes that are truly host-specific from those that do not have the opportunity to infect more than a few of the potential available hosts. Enough is known, however, to indicate rather clearly that larval trematodes are usually more specific in their molluscan hosts than are adults with respect to vertebrates.

VII. Alphabetical Host-Parasite List

Following each host species is the number of individuals examined from Curaçao (C) and/or Jamaica (J). For each parasite species, the number of infected fish is given for one or both localities. A dagger (†) indicates a trematode species found in one locality but not the other where the number of potential hosts examined indicates rarity if not absence of the parasite.

	C	J
Abudefduf saxatilis (Linnaeus), sergeant major	12	22
†*Genolinea nobli*	1	
Lecithochirium parvum		1
Parahemiurus merus		2
Schikhobalotrema adacuta		1
†*Schikhobalotrema bivesiculum*		1
Acanthurus bahianus Castelnau, ocean tang	2	
Dichadena acuta	1	
Schikhobalotrema obtusa	1	
Acanthurus coeruleus Bloch & Schneider, blue tang		5
Dichadena acuta		4
Hapladena varia		5
Hysterolecitha sogandaresi		1
Mesolecitha lineatis		1
Acanthurus hepatus (Linnaeus), doctor fish	24	22
Dichadena acuta	13	17
Hapladena varia	4	9
Hysterolecitha rosea		2
Macradena perfecta	1	4
Monorchimacradena acanthuri	8	8
Schikhobalotrema obtusa	2	
Achirus lineatus (Linnaeus), striped sole		6
Sterrhurus musculus		1
Angelichthys ciliaris (Linnaeus), queen angelfish		12
Gliphicephalus candidulus		1
Anisotremus virginicus (Linnaeus), porkfish		12
Brachadena pyriformis		1
Diphtherostomum anisotremi		3
Diplangus paxillus		1
Hamacreadium oscitans		5
Infundibulostomum anisotremi		1
Lasiotocus longicaecum		10
Lavodera decorum		1
Proctotrema anisotremi		5
Stephanostomum scutum		1
Archosargus unimaculatus (Bloch), brim		9
Brachadena pyriformis		1
Diplomonorchis micropogoni		1
Hamacreadium oscitans		1
Megasolena archosargi		5
Multitestis rotundus		4
Pachycreadium crassigulum		2
Aulostomus maculatus Valenciennes, trumpet fish	9	2
Stephanostomum aulostomi	3	
Balistes ringens Linnaeus, cocuyo	1	
Pseudocreadium galapagoensis		
Balistes vetula Linnaeus, queen triggerfish	2	2
Apocreadium balistis		1
Neoapocreadium coili		1
Pseudocreadium lamelliforme		2
Xystretrum solidum		1
Bathystoma aurolineatum (Cuv. & Val.), yellow tomtate		2
Hamacreadium ositans		1
Lasiotocus longovatus		1
Lasiotocus truncatus		1
Bathystoma striatum (Linnaeus), common tomtate		16
Brachadena pyriformis		1
Genolopa ampullacea		6
Lecithochirium parvum		1

	C	J
Bodianus rufa (Linnaeus), Spanish hogfish		1
Lepocreadium bimarinum		
Brachygenys chrysargyreus (Günther), Bronze grunt	1	
Homalometron foliatum		
Lasiotocus truncatus		
Calamus arctifrons Goode & Bean, grass porgy		4
Lepocreadium opsanusi		1
Pachycreadium crassigulum		1
Proctoeces lintoni		1
Pseudocreadium anandrum		1
Calamus bajanado (Bloch & Schneider), jolt-head porgy		5
Brachadena pyriformis		1
Cotylogaster basiri		2
Lepocreadium opsanusi		4
Pachycreadium crassigulum		1
Proctoeces lintoni		2
Pseudocreadium anandrum		1
Calamus calamus (Cuv. & Val.), saucer-eye porgy		4
Hamacreadium oscitans		1
Lasiotocus truncatus		3
Canthercines pullus (Ranzani), gray filefish	8	14
Apocreadium (immature)		2
Diplaproctodacum haustrum	2	4
Megapera pseudogyrina		9
Xystretrum solidum		1
Canthigaster rostratus (Bloch), sharp-nosed puffer	4	
Xystretrum-solidum	1	
Caranx bartholomaei (Cuv. & Val.), yellow jack		8
Alcicornis carangis		3
Bucephalus varicus		2
Ectenurus americanus		2
Ectenurus virgulus		1
Genolopa brevicaecum		2
Lecithochirium parvum		2
Stephanostomum ditrematis		3
Tergestia acuta		1
Tergestia pectinata		5
Caranx chrysos (Mitchill), hard-tailed jack	1	1
Bucephalus varicus	1	
Ectenurus americanus		1
Parahemiurus merus		1
Pseudopecoeloides carangi	1	
Stephanostomum ditrematis		1
Tergestia acuta		1
Caranx hippos (Linnaeus), common jack	1	3
Bucephalus varicus	1	3
Ectenurus americanus		2
Ectenurus virgulus		2
Lecithochirium parvum	1	2
Parahemiurus merus		2
Stephanostomum ditrematis		2
Tergestia pectinata		3
Caranx latus Agassiz, horse-eye jack	4	18
Bucephalus varicus	4	16
Lecithochirium parvum		2
Parahemiurus merus		4
Stephanostomum ditrematis		4
Stephanostomum megacephalum		4
Stephanostomum sentum		1
Tergestia pectinata	2	9
Caranx ruber (Bloch), skip-jack	1	2
Alcicornis carangis	1	
Bucephalus varicus	1	1
Pseudopecoeloides carangi	1	1
Caranx-sp., jack	1	
Bucephalus varicus		
Stephanostomum ditrematis		
Centropomus undecimalis (Bloch), snook		3
Bucephalus sp.		1
Ceratacanthus schoepfi (Walbaum), orange filefish		5
Rhagorchis odhneri		5
Chaetodipterus faber (Broussonet), spadefish		6
Allomegasolena spinosa		1
Aponurus clongatus		4
Gymnotergestia chaetodipteri		2
Multitestis blenni		4
Multitestis inconstans		5
Chaetodon capistratus Linnaeus, four-eyed butterfly fish	15	9
Hurleytrematoides chaetodoni	2	5
†*Hurleytrematoides curacaensis*	3	
†*Multitestis chaetodoni*		5
Multitestis rotundus	10	2
Chaetodon ocellatus Bloch, common butterfly fish	6	6
Hurleytrematoides chaetodoni	1	2
Hurleytrematoides curacaensis	2	
Chaetodon striatus Linnaeus, banded butterfly fish	4	7
Hurleytrematoides chaetodoni		1
Multitestis chaetodoni		4
Chloroscombrus chrysurus (Linnaeus), bumper		2
Bucephalus varicus		2
Opechona chloroscombri		2
Tergestia pectinata		2
Clepticus parrae (Bloch & Schneider) creole	1	2
Tergestia laticollis	1	1
Coryphaena hippurus Linnaeus, dolphin	3	
Dinurus barbatus	2	
Dinurus breviductus	2	
Dinurus tornatus	2	
Hirudinella-sp.	1	
Stephanostomum coryphaenae	1	
Tetrochetus coryphaenae	1	
Decapterus macarellus (Cuv. & Val.), mackerel scad	5	
Chrisomon decapteri	4	
Diodon hystrix Linnaeus, porcupine fish	6	11
†*Diplaproctodacum diodontis*		6
Opistholebes diodontis	1	2
Sclerodistomum diodontis	1	3
Tetrochetus coryphaenae		1
Doratonotus megalepis Günther, mottled sea basslet		5
Pseudopecoelus minutus		3
Dules dispilurus Günther, sandfish		14
Lecithochirium parvum		2
Echencis naucrates Linnaeus, shark remora		2
Parahemiurus merus		1
Echidna catenata Bloch, chained moray		11
Diplohurleytrema brevicaecum		3
Epinephelus adscensionis (Osbeck), rock hind	14	11
Lecithochirium parvum		3
Opecoeloides vitellosus		1
Postporus epinepheli	7	2
Sterrhurus musculus	1	
Epinephelus guttatus (Linnaeus), red hind	6	
Postporus epinepheli	1	
Epinephelus morio (Cuv. & Val.), red grouper	1	
Sterrhurus musculus		
Lepidapedon trachinoti		
Postporus epinepheli		
Epinephelus striatus (Bloch), Nassau grouper	2	6
Ectenurus americanus		1
Lepidapedon trachinoti	2	
Postporus epinepheli	1	2
Scaphanocephalus sp.		1
Stephanostomum dentatum		2
Eques acuminatus (Bloch & Schneider), cubbyu	3	2
Horatrema crassum		2
Pseudopecoeloides equesi	2	
Eques punctatus Bloch & Schneider, ribbonfish	1	
Horatrema crassum		
Pseudopecoeloides equesi		
Eucinostomus pseudogula (Cuv. & Val.), mojarra		6
Brachadena pyriformis		1
Pseudohurleytrema eucinostomi		1
Gerres cinereus (Walbaum), gray mojarra	13	16
Crassicutis gerridis	2	4
Crassicutis marina		2
Diplangus paxillus		1
†*Homalometron clongatum*		9
Pinguitrema lobata		3
Postmonorchis orthopristis		1
Pseudohurleytrema eucinostomi	2	
Steganoderma hemirhamphi		1
Stephanostomum sentum	2	
Gymnothorax funebris Ranzani, green moray	2	3
Dictysarca virens		2
Dollfustrema muraenae		2
Gymnothorax moringa (Cuvier), spotted moray	10	3
†*Dictysarca virens*		1
Dollfustrema macracanthum	3	
Dollfustrema muraenae	5	1

	C	J
Pseudopeocoelus gymnothoracis	1	
Sterrhurus fusiformis	5	1
Stomachicola rubea		1
Gymnothorax vicinus (Castelnau), brown moray	6	2
Dictysarca virens		2
Dollfustrema gymnothoracis	1	
Dollfustrema macracanthum	2	
Dollfustrema muraenae	1	
Sterrhurus fusiformis	1	
Stomachicola rubea		1
Haemulon album (Cuv. & Val.), margate fish	3	2
Genolopa ampullacea		1
Hamacreadium oscitans	2	
Homalometron foliatum	1	
Lasiotocus truncatus	1	
Postmonorchis orthopristis		1
Proctotrema pritchardi	1	
Stephanostomum sentum	1	
Sterrhurus musculus	1	
Haemulon bonariense (Cuv. & Val.), black grunt		12
Brachadena pyriformis		2
Genolopa ampullacea		1
Hamacreadium oscitans		2
Lasiotocus longovatus		4
Lasiotocus truncatus		1
Haemulon flavolineatum (Desmarest), yellow grunt	21	11
Brachadena pyriformis	3	1
Diplangus paxillus		2
Genolopa ampullacea	6	1
Homalometron foliatum	3	1
Lasiotocus longovatus	3	
Lasiotocus truncatus	1	2
†*Leurodera decora*		32
Postmonorchis orthopristis	2	3
Haemulon melanurum (Linnaeus), black-tailedgrunt	2	
Genolopa ampullacea	1	
Hamacreadium oscitans	1	
Haemulon sciurus Shaw, blue-striped grunt		16
Brachadena pyriformis		3
Diplangus parvus		1
Diplangus paxillus		2
Genolopa ampullacea		18
Hamacreadium consuetum		7
Hamacreadium oscitans		4
Helicometrina nimia		1
Homalometron foliatum		4
Lasiotocus longovatus		2
Lasiotocus truncatus		3
Leurodera decora		6
Postmonorchis orthopristis		4
Stephanostomum sentum		1
Sterrhurus musculus		4
Halichoeres pictus (Poey), painted doncella		3
Helicometra erecta		2
Schikhobalotrema adacuta		1
Hemirhamphus brasiliense (Linnaeus), balao	17	35
Haplosplanchnoides hemirhamphi		1
†*Lepocreadium hemirhamphi*	11	
Schikhobalotrema adacuta	2	27
Steganoderma hemirhamphi	2	32
Hepsetia stipes (Müller & Troschel), hard-head silverside	16	26
Schikhobalotrema adacuta		10
†*Steganoderma atherinae*		20
Holacanthus tricolor (Bloch), rock beauty	7	5
†*Antorchis holacanthi*		4
Cleptodiscus haranensis		1
Holocentrus ascensionis (Osbeck), squirrel fish	8	19
Helicometra equitata		4
Lecithochirium parvum		2
Lepidapedon truncatum	3	15
Pseudopeocoelus barkeri	1	1
†*Pseudopeocoelus holocentri*	1	
Stephanostomum pseudocarangis		1
Sterrhurus musculus	1	15
Holocentrus vexillarius (Poey), squirrel fish	1	2
Pseudopeocoelus barkeri	1	
Sterrhurus musculus		1
Hypoplectrus unicolor indigo (Poey), butter hamlet		5
Helicometrina nimia		1
Hypoplectrus unicolor (Walbaum), butter hamlet		8
Neolepidapedon hypoplectri		2
Kyphosus sectatrix (Linnaeus), white chub	1	1
Cadenatella kyphosi	1	
Labrisomus bucciferus Poey, blenny		4
Coitocaecum sp.		1
Lachnolaimus maximus (Walbaum), hogfish		5
Helicometrina nimia		1
Myzoxenous lachnolaimi		1
Lactophrys bicaudalis (Linnaeus), trunkfish	1	
Megapera gyrina		
Thysanopharynx elongatus		
Lactophrys tricornis (Linnaeus), common trunkfish	4	8
†*Dermadena lactophrysi*	2	
Megapera gyrina		2
Proctoces maculatus		1
Pseudocreadium lactophrysi	2	
Xystictum solidum		1
Lactophrys trigonus (Linnaeus), trunkfish	1	4
Dermadena lactophrysi	1	
Neoapocreadium angustum	1	
Pseudocreadium lactophrysi	1	
Lactophrys triqueter (Linnaeus), trunkfish	4	3
Dermadena lactophrysi	4	
Megapera gyrina	1	1
Pseudocreadium lactophrysi	1	1
Leptocephalus conger Linnaeus, conger eel		1
Sterrhurus musculus		
Lutianus analis (Cuv. & Val.), muttonfish	3	1
Metadena crassulata		1
Siphodera vinaledwardsii	1	1
Lutianus apodus (Walbaum), schoolmaster	18	25
Allomegasolena spinosa		1
†*Hamacreadium mutabile*		6
Lecithochirium parvum	1	
Metadena adglobosa	11	18
Metadena globosa		2
Sterrhurus musculus	1	1
Lutianus aya (Bloch), West Indian red snapper	4	
Lecithochirium parvum	1	
Metadena adglobosa	1	
Metadena crassulata	1	
Metadena globosa	1	
Paracryptogonimus neoamericanus	1	
Siphodera vinaledwardsii	1	
Stephanostomum casum	2	
Sterrhurus musculus	3	
Lutianus buccanella (Cuv. & Val.), black-finned snapper	1	
Siphodera vinaledwardsii		
Stephanostomum casum		
Lutianus griseus (Linnaeus), gray snapper	4	2
Hamacreadium mutabile		1
Lecithochirium parvum		1
Metadena adglobosa	2	1
Sterrhurus musculus	1	
Lutianus jocu (Bloch & Schneider), dog snapper	1	6
Hamacreadium mutabile		1
Helicometrina nimia		1
Metadena adglobosa		5
Lutianus mahogani (Cuv. & Val.), mahogany snapper	2	
Homalometron foliatum	1	
Lasiotocus truncatus	1	
Lutianus synagris (Linnaeus), lane snapper		16
Metadena adglobosa		3
Siphodera vinaledwardsii		14
Stephanostomum casum		3
Lutianus sp.	1	
Stephanostomum sentum		
Malacanthus plumieri (Bloch), sandfish	1	1
Sterrhurus musculus		1
Micropogon furnieri (Desmarest), croaker		6
Diplomonorchis hopkinsi		2
Diplomonorchis micropogoni		3
Lobatostoma ringens		3
Microspathodon chrysurus (Cuv. & Val.), yellow-tailed demoiselle	1	1
Schikhobalotrema pomacentri	1	1
Monacanthus hispidus (Linnaeus), filefish	3	5

	C	J
Apocreadium mexicanum		4
Mugil cephalus Linnaeus, striped mullet	2	
Haplosplanchnus mugilis	1	
Schikhobalotrema elongatum	2	
Mugil curema (Cuv. & Val.), white mullet	10	5
†*Haplosplanchnus mugilis*	9	
Schikhobalotrema elongatum		3
Mycteroperca bonaci (Poey), black grouper	5	1
Derctrema fusillus	1	
Neolepidapedon mycteropercae	1	
Prosorhynchus atlanticum	1	1
Prosorhynchus ozakii	2	
Stephanostomum dentatum	1	
Stephanostomum ditrematis	1	
Mycteroperca falcata (Poey), scamp	1	
Prosorhynchus atlanticum		
Mycteroperca venenosa (Linnaeus), yellow-fin grouper	1	
Neolepidapedon mycteropercae		
Prosorhynchus atlanticum		
Myrichthys acuminatus (Gronow), sharp-tailed eel	3	
Carneophallus lactophrysi	3	
Myrichthys ocellatus (Kaup), black-spotted snake eel	2	
Carneophallus lactophrysi	2	
Microphallus excelsus	1	
Myripristis jacobus (Cuv. & Val.), big-eyed squirrel fish	21	4
Bivesicula caribbensis	19	2
Myrophis punctatus Lutken, speckled worm eel		1
Diplomonorchis myrophitis		
Ocyurus chrysurus (Bloch), yellowtail	11	32
Lepocreadium trullae	7	13
Lepocreadium truncatum	1	
Metadena globosa		1
Paracryptogonimus neoamericanus	4	
Prosogonotrema bilabiatum		1
Siphodera vinaledwardsii	2	7
Oligoplites saurus (Bloch & Schneider), leather-jacket		4
Manteria brachydera		4
Tergestia pectinata		2
Opisthonema oglinum (Le Sueur), thread-fin herring		8
Bacciger opisthonemae		2
Neogenolinea opisthonemae		6
Parahemiurus merus		7
Tergestia pectinata		1
Peprilus paru (Linnaeus), harvest fish		1
Lepocreadium pyriforme		
Platophrys lunatus (Linnaeus), peacock flounder	1	2
Helicometrina nimia		2
Sterrhurus musculus	1	1
Pomacanthus arcuatus (Linnaeus), black angelfish	4	6
Antorchis urna	2	5
Glyphicephalus candidulus		1
Phyllodistomum pomacanthi		1
Pomacanthus paru (Bloch), French angelfish	5	4
Antorchis urna	4	1
Pomacentrus anatis Poey, blue-spotted demoiselle	1	
Schikhobalotrema pomacentri		
Pomacentrus fuscus Cuv. & Val., brown demoiselle	20	14
Schikhobalotrema pomacentri	3	9
Pomacentrus leucostictus Müll. & Trosch., beau-gregory	4	2
Schikhobalotrema pomacentri	1	
Theletrum pomacentri		1
Priacanthus cruentatus (La Cépede), big-eye	3	
Ectenurus virgulus	1	
Prionotus punctatus (Bloch), spotted sea-robin		4
Sterrhurus musculus		1
Promicrops itaiara (Lichtenstein), jewfish		1
Prosorhynchus promicropsi		
Pseudoscarus guacamaia (Cuvier), rainbow parrotfish	9	10
Haplodena oralis		1
Schikhobalotrema adbrachyura	6	4
Schikhobalotrema heterocotylum	1	
Schikhobalotrema sparisomae	3	8
Pseudoscarus plumbaeus Bean, purple parrotfish		2
Schikhobalotrema adbrachyura		1
Rypticus saponaceus (Bloch & Schn.), soapfish	5	2
Prosorhynchus aquayoi	1	2
Sterrhurus musculus	1	
Sardinella anchovia (Cuv. & Val.), Spanish sardine	6	7
†*Neogenolinea opisthonemae*		6
Parahemiurus merus	1	7
Sardinella macrophthalmus (Ranzani), big-eyed sardine	6	14
Ectenurus virgulus		8
Lecithochirium parvum		3
Neogenolinea opisthonemae		2
Opechona sardinellae		2
Parahemiurus merus		12
Pseudobacciger manteri		2
Scarus croicensis (Bloch), Bahama parrotfish	6	1
Schikhobalotrema sparisomae	3	
Scarus sp.		1
Schikhobalotrema sparisomae		
Scomberomorus cavalla (Cuv. & Val.), king mackerel	2	1
Rhipidocotyle baculum	1	
Bucephaloides arcuatus	1	1
Scorpaena plumieri Bloch, West Indian scorpion fish	17	7
Bucephalus scorpaenae	10	3
Hirudinella sp.	1	
Lecithochirium parvum		1
†*Neopecoelus scorpaenae*	10	
Sterrhurus musculus	6	6
Selar crumenophthalmus (Bloch), goggle-eyed scad		10
Chrisomon sp.		1
Ectenurus americanus		6
Ectenurus virgulus		2
Lecithochirium microstomum		10
Lecithochirium parvum		2
Pseudopecoeloides gracilis		8
Sterrhurus musculus		3
Tergestia pectinata		8
Seriola dumerili (Risso), great amberjack	1	4
Bucephalus varicus		2
Ectenurus americanus		1
Lecithochirium microstomum		2
Lecithochirium parvum	1	
Parahemiurus merus		1
Tormopsolus orientalis	1	
Sparisoma abildgaardi (Bloch), red parrotfish	2	2
Schikhobalotrema sparisomae	1	1
Sparisoma brachiale (Poey), parrotfish		2
Haplodena oralis		1
Schikhobalotrema sparisomae		2
Sparisoma flavescens (Bloch & Schn.), mud parrotfish	25	14
Haplodena oralis		3
Schikhobalotrema adbrachyura	3	
Schikhobalotrema sparisomae		14
Sparisoma radians (Cuv. & Val.), radiant parrotfish		2
Schikhobalotrema sparisomae		2
Sparisoma viride (Bonnaterre), green parrotfish	1	
Schikhobalotrema adbrachyura		
Spheroides spengleri (Bloch), southern swellfish		4
Diploproctodaeum plicitum		4
Helicometrina nimia		1
Spheroides testudineus (Linnaeus), West Indian puffer	4	13
Diplomonorchis sphaerovarium		5
Diploproctodaeum plicitum		6
Nystretrum solidum		10
Sphyraena barracuda (Shaw), barracuda	6	3
Bucephaloides longicirrus	1	3
Bucephaloides longoviferus	2	1
Strongylura ardeola (Cuv. & Val.), needlefish	1	
Schikhobalotrema acuta		
Steganoderma nitens		
Strongylura raphidoma (Ranzani), houndfish		12
Schikhobalotrema acuta		3
Strongylura timucu (Walbaum), timucu	16	3
Schikhobalotrema acuta	1	
Steganoderma atherinae	1	
Synodus intermedius (Agassiz), lizardfish	3	4
Ectenurus americanus		3
Lecithochirium microstomum		1
Lecithochirium parvum		1
Sterrhurus musculus	2	2
Trachinotus glaucus (Bloch), palometa		1
Ectenurus virgulus		

	C	J
Helicometrina trachinoti		
Sterrhurus musculus		
Upeneus maculatus Bloch, red goatfish	6	4
Opecoeloides brachyteleus	1	2
Opecoeloides elongatus	5	3
Upeneus martinicus Cuv. & Val., yellow goatfish	13	9
Lecithochirium parvum		1
Opecoeloides brachyteleus	4	4
Opecoeloides elongatus	9	5

VIII. List of Negative Fishes

Numbers preceding the letters C and J are of individuals examined in Curaçao and Jamaica, respectively.

Albula vulpes (Linnaeus), bonefish, 3C
Anchoviella epsetus (Bonnaterre), striped anchovy, 1C, 13J
Antennarius ocellatus (Bloch & Schn.), spotted frogfish, 1C
Apogon binotatus (Poey), cardinal fish, 2C
Apogon conklini (Silvester), Conklin's cardinal fish, 1J
Apogon maculatus (Poey), cardinal fish, 9C
Apogon sp., 2C
Apogonichthys stellatus Cope, conchfish, 1C
Bathygobius soporator (Cuv. & Val.), mapo, 19C, 6J
Cephalacanthus volitans (Linnaeus), flying gurnard, 4C
Cephalopholis fulvus (Linnaeus), coney, 5C, 1J
Cerataeanthus scripta (Osbeck), scrawled filefish, 2J
Celengraulis edentulus (Cuvier), whalebone anchovy, 17J
Chilomycterus atinga (Linnaeus), spotted boxfish, 2J
Chromis marginatus (Castelnau), reef-fish, 19C
Cypselurus bahiensis (Ranzani), flyingfish, 8C
Decapterus punctatus Agassiz round scad, 2C
Diapterus rhombeus (Cuv. & Val.), rhomboild mojarra, 8J
Elcotris perniger (Cope), goby, 7J
Elops saurus Linnaeus, ten-pounder, 5C
Erotelis smaragdus (Cuv. & Val.), emerald goby, 3C
Etropus crossotus Jordan & Gilbert, fringed flounder, 2J
Fistularia labacaria Linnaeus, cornet fish, 1C
Gramma hemichrysos, royal gramma, 1C
Gymnothorax ocellatus Agassiz, ocellated moray, 3C
Haemulon macrostomum Günther, gray grunt, 1J
Halichoeres bivittata (Bloch), slippery dick, 7C
Halichoeres kirschii (Jord. & Ever.), Kirsche's wrasse, 3C
Hippocampus punctulatus Guichenot, spotted seahorse, 1C, 1J
Hirundichthys affinis (Günther), four-winged flyingfish, 1C
Hypoplectrus unicolor nigricans (Poey), vaca, 1J
Labrisomus nuchipennis (Quoy & Gaim.), hairy blenny, 9C, 6J
Lophogobius cyprinoides (Pallas), crested goby, 6J
Lophogobius glaucofraenum (Gill), bridled goby, 5C
Microgobius sp., goby, 4C
Monacanthus tuckeri Bean, Tucker's filefish, 5C
Mollinesia vandepolli (Van Lindth de Jeude), killifish, 1C
Odontoscion dentex (Cuv. & Val.), corvina, 1J
Ogcocephalus vespertilio (Linnaeus), batfish, 1C
Ophichthus sp., snake eel, 1C
Opisthognathus aurifrons (Jord. & Thomp.), jawfish, 1C
Pempheris mulleri Poey, glassy pempherid, 2C
Priacanthus arenatus Cuv. & Val., common big-eye, 1C
Prionodes tigrinus (Bloch), harlequin serranid, 1C
Rupiscartes atlanticus (Cuv. & Val.), rock-skipper, 3C, 2J
Rypticus bistrispinus (Mitchill), two-spined soapfish, 2J
Scarus caeruleus (Bloch), blue parrotfish, 1J
Stegastes nivatus (Poey), turquoise-spotted demoiselle, 1C
Strongylura notatus (Poey), needlefish, 1J
Syngnathus elucens Poey, Poey's pipefish, 11J
Thalassoma bifasciatum (Bloch), blue-head, 12C

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X. Abstract

Examination of 1527 fishes representing 185 species yielded 178 species of trematodes including 39 new species, for 5 of which new genera are erected. New species in previously known genera, their hosts, localities (C = Curaçao, J = Jamaica), and families are: *Dollfustrema gymnothoracis* from *Gymnothorax vicinus*, C, (Bucephalidae); *Infundibulostomum anisotremi* from *Anisotremus virginicus*, J; and *Bacciger opisthonemae* from *Opisthonema oglinum*, J, (Fellodistomatidae); *Haplosplanchnus mugilis* from *Mugil curema*, C; *Schikhobalotrema bivesiculum* from *Abudefduf saxatilis*, J; *S. elongatum* from *Mugil cephalus* and *M. curema*, C, J; and *S. heterocotylum* from *Pseudoscarus guacamaia*, C, (Haplosplanchnidae); *Megapera pseudogyrina* from *Cantherines pullus*, J, (Megaperidae); *Crassicutis gerridis* from *Gerres cinereus*, C, J; *Neolepidapedon hypoplectri* from *Hypoplectrus unicolor*, J; *Opechona chloroscombri* from *Chloroscombrus chrysurus*, J; *O. sardinellae* from *Sardinella macrophthalmus*, J; *Lepocreadium truncatum* from *Ocyurus chrysurus*, C; *L. hemiramphi* from *Hemiramphus brasiliensis*, C; *Cadenatella kyphosi* from *Kyphosus sectatrix*, C; *Diploproctodaeum diodontis* from *Diodon hystrix*, J; and *Pseudocreadium lactophrysi* from *Lactrophrys tricornis*, C, J, (Lepocreadiidae); *Pseudopecoelus holocentri from Holocentrus ascensionis*, C; *P. gymnothoracis* from *Gymnothorax moringa*, C; and *P. minutus* from *Doratonotus megalepis*, C, (Opecoelidae); *Phyllodistomum pomacanthi* from *Po-*

macanthus arcuatus, J, (Gorgoderidae); *Diphtherostomum anisotremi* from *Anisotremus virginicus*, J, (Zoogonidae); *Proctotrema pritchardae* from *Haemulon album*, C; *P. anisotremi* from *Anisotremus virginicus*, J; *Chrisomon decapteri* from *Decapterus macarellus*, C; *Hurleytrematoides curacaensis* from *Chaetodon capistratus*, C; *Diplomonorchis myrophitis* from *Myrophis punctatus*, J; *D. micropogoni* from *Micropogon furnieri* and *Archosargus unimaculatus*, J; *D. hopkinsi* from *Micropogon furnieri*, J; and *D. sphaerovarium* from *Spheroides testudineus*, J, (Monorchiidae); *Stephanostomum aulostomi* from *Aulostomus maculatus*, C, (Acanthocolpidae); *Genolinea noblei* from *Abudefduf saxatilis*, C; *Hysterolecitha sogandaresi* from *Acanthurus coeruleus*, J; and *Theletrum pomacentri* from *Pomacentrus leucosticus*, J, (Hemiuridae).

New genera and species, their hosts, localities and families are: *Gymnotergestia chaetodipteri* from *Chaetodipterus faber*, J; *Pseudobacciger manteri* from *Sardinella macrophthalmus*, J (Fellodistomatidae); *Haplosplanchnoides hemiramphi* from *Hemiramphus brasiliensis*, J (Haplosplanchnidae); *Diplohurleytrema brevicaecum* from *Echidna catenata*, C (Monorchiidae); *Monorchi-macradena acanthuri* from *Acanthurus hepatus*, C, J (Hemiuridae).

New names for previously misidentified species are: *Pseudobacciger manteri*, *Pseudopecoelus holocentri* (listed above), and *Alicornis siddiqii* (Puerto Rico). New combinations are: *Cleptodiscus havanensis* for *Macrorchitrema h.*, *Cadenatella brumpti* for *Jeancadenatia b.*, and *Cadenatella dohenyi* for *Jeancadenatia d.*

The following species are reduced to synonomy as indicated: *Proctoeces neomagnoris* = *Mesolecitha linearis*; *Lepidapedon holocentri* = *L. truncatum*; *Pseudoplagioporus brevivitellus* = *Hamacreadium oscitans*; *Steganoderma elongatum* = *S. nitens*; *Genolopa longicaudata* = *G. ampullacea*; and *Aponurus symmetrorchis* = *Brachadena pyriformis*.

Possible affinity of the *Enenterum* group with the *Haploporoidea* is discussed. The Suborder Acanthocolpiata and Superfamily Acanthocolpoidea are proposed for the Family Acanthocolpidae, and placed in the Order Opisthorchiida, Superorder Epitheliocystidia of La Rue's system.

Data concerning geographical distribution and host-parasite specificity are presented in tables and discussed.

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